

Amanda L. Golbeck *Editor*

# Leadership in Statistics and Data Science

Planning for Inclusive Excellence

 Springer

# Leadership in Statistics and Data Science

Amanda L. Golbeck

Editor

# Leadership in Statistics and Data Science

Planning for Inclusive Excellence

 Springer

*Editor*

Amanda L. Golbeck  
University of Arkansas for Medical  
Sciences  
Little Rock, AR, USA

ISBN 978-3-030-60059-4      ISBN 978-3-030-60060-0 (eBook)  
<https://doi.org/10.1007/978-3-030-60060-0>

© Springer Nature Switzerland AG 2021

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors, and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

*To Craig and Dan  
In memory of Freya*

# Preface

I decided to develop this book because I was intrigued by what I was reading on the web about two new styles of leadership: humanistic leadership and inclusive leadership. I wanted to bring these new ideas to the statistics and data science community for thoughtful consideration, examination, and amplification. The question I ultimately found most compelling is: How can all of us make use of humanism, inclusion, and related competencies to help propel our statistics and data science workplaces toward inclusive excellence?

As an administrator, as well as in situations where I am an untitled leader, I have a passion for improving the systems, climates, and cultures in places where STEM (science, technology, engineering, mathematics, medicine) professionals and academics work. As a colleague, I want to provide a platform where others can have a voice about improvement. This book is one such platform. The passions of the contributors for achieving inclusive excellence in our workplaces have resulted in the 26 outstanding contributions that comprise this book.

These contributions are meant to provide a window into the topic of leadership and inclusive excellence. They are organized into nine sections: opportunity for the profession, leading teams, connecting with teams, connecting within organizations, organizing within academe, arguing for full inclusion, data telling and storytelling, life telling, and leading the profession. This book is purposely action-oriented: Every contributor has included at the end of their chapter some suggested action steps that you, the reader, can take toward inclusive excellence in your workplace.

Each contributor to this book has a unique and impressive set of professional accomplishments as described in their brief biographies at the front of this book. Some have been administrators in their workplaces (including a former chief statistician of the United States). Some have been officers in our professional associations (including the second woman to be president of the International Statistical Institute, founded in 1885). Some have been leaders of diversity and inclusion initiatives (including the founder of the JSM Diversity Workshop and Mentoring Program). Others are emerging administrators, officers, or flag-bearers, and brilliant statistical leaders on multidisciplinary teams. All are thought leaders in our profession for inclusive excellence.

Contributors are from all of the major sectors of employment (business/industry, government, academe). Some contributors are from across the United States (north, south, east, west). Others are from across the globe (United Kingdom, Latvia, Croatia, Australia). They mostly call themselves statisticians, data scientists, biostatisticians, mathematical scientists, or mathematicians. Also contributing are some who collaborate with statisticians and data scientists (including the editor of a statistics magazine that is distributed to every member of the Royal Statistical Society and the American Statistical Association).

Every contributor is a thought leader who brings courage to their leadership skill set. Courage is an important ingredient in leadership. I commend all of them for writing about the difficult topics expressed in this book. Many people do not have a fluent public vocabulary about leadership, much less diversity, equity, and inclusion. A premise of this book is that all will benefit from self-reflection about these matters and from engaging in more discourse about them. A number of contributors expressed to me that they were stretched—in good ways—by composing their chapters. I thank them for this sincere gift.

I also extend my profound thanks to all of the Contributors, as well as to Craig Molgaard at home and Laura Briskman at Springer Nature. I am honored that all of these friends, old and new, have accompanied me on this journey. I invite you to join us by reading this book, engaging in the conversation, forming a personal vision about your work environment, and taking some action to achieve your vision.

Our good colleague Allan Sampson, who contributed an excellent chapter on disability, passed away as this book was going to press. Allan lived a life of inclusive excellence. We learned from Allan, and we are thankful to have known him.

Little Rock, AR, USA

Amanda L. Golbeck

# Contents

## Part I Opportunity for the Profession

<b>The Changing Culture of Statistics and Data Science: A Vision for the Profession</b> .....	3
Amanda L. Golbeck and Craig A. Molgaard	

<b>Power and Privilege: Reshaping the Opportunity Structure for Equitable Leadership in Statistics and Data Science</b> .....	19
Emma Benn	

## Part II Leading Teams

<b>Leading Collaboration in the Data Zone</b> .....	31
Nancy Fagenson Potok	

<b>Team Science in Biostatistical Collaboration: An Opportunity to Practice Leadership, Embrace Diversity, Manage Conflict, and Share Credit</b> .....	47
Jaya M. Satagopan and Madhu Mazumdar	

<b>Inclusive Leadership Across Cultures and Cultural Intelligence at Home</b> .....	65
James J. Cochran	

## Part III Connecting with Teams

<b>Empathy, Humor and Other Emotional Skills in Leadership</b> .....	89
Sandra Sebre, Ieva Stokenberga, and Sanita Šaitere	

<b>Personal and Collective Development Via Conversational Intelligence</b> ....	105
Adriana Pérez	

<b>The Neuroscience of Human Connection and Leadership</b> .....	117
Nicole A. Lazar	



## **Part IV Connecting Within Organizations**

<b>Perspectives on Inclusive Leadership for Statisticians in Industry</b> .....	131
Ellen Sim Snyder, Lisa Lupinacci, and Nora Vele	
<b>Diversity and Inclusion in the Federal Government</b> .....	153
Wendy L. Martinez and Donna LaLonde	
<b>Leading and Managing Diversity in the Private Sector</b> .....	165
Mary Batcher and Edward Mulrow	
<b>Diversity and Inclusion in Talent Acquisition</b> .....	171
Adrian Coles	

## **Part V Organizing Within Academe**

<b>Leadership and Diversity in Statistics: Great Initiatives by Faculty Advocates</b> .....	187
Marcia Gumpertz and Jacqueline M. Hughes-Oliver	
<b>University Faculty Salaries: Comparing Patterns of Gender Inequity to Those in the General Workforce</b> .....	203
Mary C. Meyer	
<b>Establishing and Maintaining Inclusive Pipelines</b> .....	211
Jeffrey D. Dawson and Gideon K. D. Zamba	

## **Part VI Arguing for Full Inclusion**

<b>Statistics as a Tool for Equity</b> .....	221
Mary W. Gray	
<b>Inclusion of Individuals with Disabilities</b> .....	239
Allan R. Sampson	
<b>How the Legal System’s Failure to Appreciate Statistical Evidence Disadvantages Plaintiffs in Discrimination Cases</b> .....	255
Joseph L. Gastwirth	

## **Part VII Data Telling and Storytelling**

<b>Data, Imagination, and Action in the Profession of Statistics: Working with the Annual and CBMS Surveys</b> .....	275
Thomas H. Barr	
<b>“And Oh the Stories We Could Tell”: Why Numbers Need a Narrative</b> .....	293
Brian Tarran	
<b>The Power of Narrative in the Quest for Diversity and Inclusion</b> .....	309
Brian A. Millen	

**Part VIII Life Telling**

<b>The Coin That Improbably Landed on Its Edge</b> .....	321
Ksenija Dumičić	

<b>Independence and Diversity as Taught by My Mentors</b> .....	341
Bin Yu	

<b>My Journey to Leadership</b> .....	349
Reneé H. Moore	

**Part IX Leading the Profession**

<b>Why Statistics Needs Thought Leaders and How You Can Become One</b> .....	371
Jessica Utts and Barbara Goretsky	

<b>Leadership Across the Diversity of Statistics</b> .....	387
Helen MacGillivray	

<b>Index</b> .....	411
--------------------	-----

# About the Editor

**Amanda L. Golbeck** is a statistician, social scientist, and academic leader. She received her PhD from UC-Berkeley and is currently Professor of Biostatistics and Associate Dean for Academic Affairs in the Fay W. Boozman College of Public Health at the University of Arkansas for Medical Sciences. She is a Fellow of the American Statistical Association (ASA), an Elected Member of the International Statistical Institute, a past-president of the Caucus for Women in Statistics, and a former Fulbright Specialist to the University of Latvia at Riga. Golbeck has over 130 publications in medical sciences and history of science and is best known for her books *Leadership and Women in Statistics* (edited with I. Olkin and Y. Gel) and *Equivalence: Elizabeth L. Scott at Berkeley*, both published by Chapman and Hall/CRC. Golbeck was selected in 2016 to receive the Committee of Presidents of Statistical Societies Elizabeth L. Scott Award. Her citation read: “for her outstanding efforts in enhancing the status of women and minorities, fostering new leadership opportunities for women and men, promoting diversity at all levels, and advocating for a more inclusive, open and supportive atmosphere in statistical sciences.”

## About the Authors

**Thomas H. Barr** is Director of Programs at the American Mathematical Society in Providence Rhode Island and a visiting scholar at Brown University. At AMS, his portfolio currently includes the Society's Mathematics Research Communities program, career development initiatives, the Mathematical and Statistical Sciences Annual Survey, and the CBMS Survey of Undergraduate Mathematics Programs. Prior to AMS, he served as a business planning consultant and chief operations officer of a life science startup company, and before that as professor and chair of the Mathematics and Computer Science Department at Rhodes College. He has a PhD in Mathematics from Vanderbilt University and an MBA from the University of Alabama Birmingham.

**Mary Batcher** is a partner at BDS Data Analytics where she is building the statistics business for a new company, following her retirement from Ernst & Young (EY). At EY, she was an Executive Director in the National Tax Department where she built a statistics practice that enabled or enhanced the delivery of several million dollars of tax projects per year. She identified areas where statistical methods could be useful in new business settings and oversaw the quality and accuracy of the statistical work performed by EY statisticians. Mary has also been an occasional expert statistical witness on behalf of EY clients. Before joining Ernst & Young, Mary led a similar practice in the Statistics of Income Division of the IRS. At the IRS, she provided statistical guidance for the testing and implementation of innovative efforts to improve the taxpayer experience in dealing with the IRS. Mary holds a Ph.D. in statistics from the University of Maryland and is a Professional Statistician, accredited by the American Statistical Association for sound and ethical statistical practice. She is an elected member of the International Statistical Institute and an elected Fellow of the American Statistical Association.

**Emma Benn** (*pronouns: she/her*) is an Associate Professor in the Center for Biostatistics and Department of Population Health Science and Policy at the Icahn School of Medicine at Mount Sinai. While Dr. Benn is very passionate about applying her biostatistical expertise to meaningful research aimed at reducing and eliminating health disparities, she is also very committed to ensuring that

the field of (bio)statistics and data science is diverse and inclusive with ample opportunities for equitable advancement to leadership for racial/ethnic minorities, women, and LGBTQ+ and gender non-conforming individuals. Dr. Benn is the co-founder of the NHLBI-funded BEST Diversity Program aimed at increasing exposure of underrepresented undergraduates to biostatistics and its applications in cardiovascular and public health research. She is also an Executive Committee member and former co-Chair of the ENAR Fostering Diversity in Biostatistics Workshop and a mentor for the JSM Diversity Workshop and Mentoring Program and the Math Alliance. Dr. Benn has served as an appointed member to the ASA Task Force on Sexual Harassment and Assault and is currently serving as a member of the ENAR Regional Committee and ASA Investments Committee. She is honored to be among such progressive and thought-provoking leaders contributing to this book.

**James J. Cochran** is Associate Dean for Research, Professor of Statistics, and Rogers-Spivey Faculty Fellow with the University of Alabama's Culverhouse College of Business. He has been a Visiting Scholar with Stanford University, University of South Africa, Universidad de Talca, Pôle Universitaire Léonard De Vinci, University of Limpopo, and University of Namibia. He holds honorary appointments with the University of KwaZulu Natal and University of Limpopo. Cochran established an international teaching effectiveness colloquium series and organized nineteen of these events on six continents. He is founding Editor-in-Chief of the *Wiley Encyclopedia of Operations Research and the Management Sciences*, *Wiley Series in Operations Research and Management Science*, and *INFORMS Analytics Body of Knowledge*. He has authored/coauthored fourteen book chapters, over forty research articles, and seven textbooks. He has consulted with corporations, governments, and NPOs worldwide. He was founding co-chair of Statistics without Borders and a founding committee member for the INFORMS Pro Bono Analytics initiative. He has delivered keynotes to conferences in 25 nations. Cochran has received the INFORMS Prize for Teaching of OR/MS Practice, Mu Sigma Rho Statistical Education Award, Waller Distinguished Teaching Career Award, Karl Peace Award, ASA Founders Award, and INFORMS President's Award. He is a Fellow of the ASA and INFORMS.

**Adrian Coles** is currently a Senior Research Scientist at Eli Lilly and Company. He supports early phase research in pain and neurodegeneration as well as non-technical enterprise-level initiatives, such as diversity recruitment. He is the current chair of the American Statistical Association's Committee on Minorities in Statistics, a group that delivers two crucial annual programs that aim to increase participation in statistics and data science by members of historically underrepresented racial and ethnic groups. Dr. Coles also serves as the Math Alliance Associate Director for Industrial Relations, an organization whose primary aim is to increase the number of doctoral degrees in the mathematical sciences among groups that have been traditionally underrepresented in those fields. Before coming to Lilly, he was a clinical researcher and instructor at the Duke University School of Medicine and IQVIA. Dr. Coles holds an MS and PhD in Statistics from NC State University,

where he was the first African American male to earn a PhD in Statistics from the time-honored department. Prior to attending graduate school, Dr. Coles served nearly 9 years in the United States Marine Corps and has received several military awards and decorations for outstanding service and leadership.

**Jeffrey D. Dawson** received his B.S. in Statistics from Brigham Young University in 1987 and his Sc.D. in Biostatistics from Harvard University in 1991. He is currently a Professor of Biostatistics and the Associate Dean for Faculty Affairs in the College of Public Health at the University of Iowa (UI), having served as the Director of Graduate Studies in Biostatistics from 2003 to 2012. His methodological research includes longitudinal data, clinical trials, missing data, and time series. He has collaborated with dozens of faculty across all UI colleges, resulting in multiple publications and grants in areas such as driving studies, cardiovascular health, neuropsychology, infectious diseases, elderly abuse, obstetrics, and physical therapy. He has been a mentor in the Iowa Summer Institute in Biostatistics since its inception. He was instrumental in the development of the UI undergraduate major in Public Health and also developed the Scholarly Integrity in Biostatistics course for graduate students. He has been involved in public health outreach and educational activities in Haiti, Mexico, and the Dominican Republic. He is on the editorial board for *Neurosurgery* and is a fellow of the American Statistical Association.

**Ksenija Dumičić** is a tenured full Professor in the Department of Statistics, University of Zagreb, Faculty of Economics and Business (FEB), with research interests in survey sampling, research methods, and statistical quality control. She is Chair of the Postgraduate Study Program in Statistics at FEB and is formerly the Head of the Department of Statistics (2006–2010). She teaches at the PhD level in universities in Croatia and neighboring countries. Dumičić is an Elected Member of the International Statistical Institute (ISI), where she serves on the Management Committee on Women and mentors Young Statisticians; and she is a Fellow of the Royal Statistical Society, the American Statistical Association, and the American Society for Quality's Statistical Division. She obtained continuing education in survey sampling research techniques at the University of Michigan and the University of Southampton (UK). As the Croatian Statistical Association President (2015–2019), she co-founded the International Statistical Conference in Croatia. She co-founded the *Croatian Review of Economic, Business and Social Statistics* and is currently its Editor-in-Chief. She also co-founded the opinion research agency Ipsos West Adria, which is situated in Croatia and operates internationally. She has led scientific projects which were funded by the World Bank, UNICEF, WHO, EC, etc., and has 260 publications.

**Joseph L. Gastwirth** has written two books on legal statistics and over 300 peer-reviewed articles in both the theory and applications of statistics. He is a Fellow of the American Statistical Association, Institute of Mathematical Statistics, and AAAS. He received a Guggenheim Fellowship for his work in law and public policy, the Julius Shiskin award in Economic Statistics for his research on measuring income inequality and discrimination, the Gottfried Noether award for his early

work in nonparametric and robust statistical methods, and the Karl Peace award for statistical contributions to society for his research in legal statistics and inequality. The methods he and his coauthors developed have been cited in several legal cases concerning employment discrimination and equal pay as well as the Equal Employment Opportunity Commission and Office of Federal Contract Compliance. His recent work on statistical methods for examining data on peremptory challenge data for evidence that they were improperly used to exclude African Americans and other minorities was cited by two courts in 2018.

**Barbara Goretsky** is a seasoned corporate consultant and executive coach. She has over 30 years' experience working in Fortune 100 companies, government agencies, and smaller, private firms. Barbara is a former senior HR executive where she led Northrop Grumman's learning and leadership development efforts that included: organizational strategies for developing leaders at all levels, in-residence programs, executive coaching initiatives, and rotational, stretch assignments. She also led the organization's succession planning process, high potential programs, and learning programs for all employees. She is known as a thought leader and change leader who can develop and align talent development efforts with business strategies. Barbara coaches her clients to think strategically and to execute effectively, while also examining their own leadership style and how it impacts organizational results. Her passion for personal and professional growth has helped clients leverage their natural talents for the benefit of their organizations, their teams, and themselves. Barbara has a MA in communications from the Pennsylvania State University and a MS in human resource management from the American University. She also has the following certifications: International Coach Federation (ICF), Senior Professional Human Resources (SPHR), Myers-Briggs Type Indicator (MBTI), Profilor 360, VOICES 360, and Hogan Assessment.

**Mary W. Gray** is a professor of mathematics and statistics at American University, Washington DC. Her PhD is from the University of Kansas and she has a JD from the Washington College of Law, American University. Professor Gray has over 100 publications in the fields of statistics, law, mathematics, economics, and education. She also reviews operas, plays, films, and mysteries related to mathematics. A fellow of the American Statistical Association, the American Mathematical Society, and the American Association for the Advancement of Science, she is the recipient of a Presidential Award for Excellence in STEM Mentoring, the American Statistical Association Karl Peace Award, and several honorary doctorates. Professor Gray is the founder of the Association for Women in Mathematics and past-president of the Caucus for Women in Statistics and has been the chair of the US section and international treasurer of Amnesty International. Her current writing projects include a book on statistics for lawyers and a column on law for a statistics journal. She teaches a course on legal and ethical issues in computer science and a survey sampling course featuring the involvement of students in community projects.

**Marcia Gumpertz** is Professor of Statistics at North Carolina State University. She teaches applied statistics, design of experiments, and statistical consulting practice.

Dr. Gumpertz is coauthor of the textbook *Planning, Construction and Statistical Analysis of Comparative Experiments* and is a Fellow of the American Statistical Association. From 2006 to 2017 she served as assistant vice provost for faculty and staff diversity at NC State. In that role she worked with faculty and administrators to promote diversity and inclusion among faculty and staff throughout the university. She chaired the NC State Faculty Salary Equity Study committee, conducted faculty exit interviews, and served as PI on NC State's NSF-funded ADVANCE project: Developing Diverse Departments. Dr. Gumpertz coauthored "Maybe We're Not So Smart: Identifying Subconscious Bias and Micro-aggressions in Academia" (*Diverse Issues in Higher Education*) and "Retention and Promotion of Women and Underrepresented Minority Faculty in Science and Engineering at Four Large Land Grant Institutions" (*PLoS One*). She is currently PI of NC State's NSF-funded Alliances for Graduate Education and the Professoriate (AGEP) project: An Institutional Transformation Model to Increase Minority STEM Doctoral Student and Faculty Success.

**Jacqueline M. Hughes-Oliver** is Professor of Statistics at North Carolina State University. She previously served as Director of the Exploratory Center for Cheminformatics Research (2005–2009) and as Director of Graduate Programs for the Department of Statistics (2007–2010). Her methodological research focuses on prediction and classification, analysis of high-dimensional data, variable and model selection with dimension reduction, design and analysis of pooling or mixture experiments, optimal design, and spatial modeling. Application areas include drug discovery and cheminformatics, ontology-driven analysis of microarray studies, metabolomics, point sources, environmental modeling, engineering manufacturing, and transportation modeling. Her research-related awards include the American Statistical Association's 2006 Statistics in Chemistry Award, Fellow of the American Statistical Association in 2007, and the Blackwell-Tapia Prize in 2014. Dr. Hughes-Oliver is passionate about outreach to underrepresented groups in the mathematical and statistical sciences. She has extensive service to conferences and workshops such as StatFest, Field of Dreams, Infinite Possibilities, Joint Statistical Meetings Diversity Program and Mentoring Workshop, and ENAR Diversity Workshop. She also currently serves on a number of boards focused on broadening participation, including the National Alliance for Doctoral Studies in the Mathematical Sciences and the African Diaspora Joint Mathematics Workshop (ADJOINT).

**Donna LaLonde** is the Director of Strategic Initiatives and Outreach at the American Statistical Association (ASA) where she works with talented colleagues to advance the vision and mission of the ASA. Prior to joining the ASA, Donna was a faculty member at Washburn University and also served in various administrative positions including interim chair of the Education Department and Associate Vice President for Academic Affairs. As a faculty member in the Department of Mathematics and Statistics she was a champion of undergraduate research. In her time at the ASA, Dr. LaLonde has been heavily involved in student outreach and is a member of the Executive Committee for the Women in Statistics and Data Science Conference.



**Nicole A. Lazar** is Professor of Statistics at Pennsylvania State University. She earned her BA in Statistics and Psychology at Tel Aviv University, MS in Statistics at Stanford University, and PhD in Statistics at the University of Chicago. Dr. Lazar has been on the faculty at Carnegie Mellon University and the University of Georgia. She is an Elected Member of the International Statistical Institute and a Fellow of the American Statistical Association. She is a former Editor in Chief of “The American Statistician” and in 2019 served as President of the Caucus for Women in Statistics. Her research interests include likelihood theory, foundations of statistical inference, the analysis of complex high-dimensional data (with an emphasis on functional neuroimaging), and Bayesian methods. She is the author of “The Statistical Analysis of Functional MRI Data” and has published extensively in the statistics and neuroscience literature.

**Lisa Lupinacci** is the Vice President of Late Development Statistics at Merck and Co, Inc. She oversees the statisticians who support all Phase 2–5 drug and vaccine development programs at Merck. In her 23 years in the biopharmaceutical industry (all at Merck), Lisa has worked as a statistician, a drug development team leader, and a clinical director. She has considerable experience in vaccine, infectious disease, and oncology disease areas. Lisa has been a manager for 17 years of groups ranging in size from 5 to 150. She gives many presentations on leadership and career development as well as serves on panels with the leaders of biostatistics organizations at other large pharmaceutical companies and regulatory agencies to discuss statistical leadership and future directions for statistical organizations. Lisa is a member of the American Statistical Association (ASA) and member of the executive committee of the Biopharmaceutical Section of the ASA. She is also a core member of the Leadership in Practice Committee within the Biopharmaceutical Section. Lisa holds a B.S. degree in mathematics from Villanova University and M.S. and Ph.D. degrees in Statistics from Virginia Tech.

**Helen MacGillivray** is only the second Australian and second female to be President of the International Statistical Institute in its 135-year history. She was an inaugural Australian Senior Learning and Teaching Fellow, first female President and Honorary Life Member of the Statistical Society of Australia, and a past-President of the International Association for Statistical Education. She is Editor of *Teaching Statistics*, a Principal Fellow of the Higher Education Academy, and is the inaugural Chair of the UN Global Network of Institutions for Statistical Training. She has received many national awards and grants and published textbooks, chapters, keynotes, invited and refereed papers on authentic statistical learning and assessment, curricula design, learning support, and research topics in distributions. Helen has chaired reviews of university departments and centers across Australia and internationally and organized international and national conferences. Her many university leadership roles include developing, coordinating, and leading teaching of diverse university programs, and founding and directing university-wide Maths Access Centres, Symposia in Statistical Thinking, and mentored developmental programs in university teaching. Helen has played key roles in school education in curricula, professional development, resources, assessment, and innovative and

successful extension and enrichment programs for thousands of secondary school students.

**Wendy L. Martinez** has been the Director of the Mathematical Statistics Research Center at the U.S. Bureau of Labor Statistics (BLS) for 7 years. Prior to this, she worked in several research positions throughout the Department of Defense. She held the position of Science and Technology Program Officer at the Office of Naval Research, where she established a research portfolio comprised of academia and industry performers developing data science products for the future Navy and Marine Corps. She is the lead author of three books on MATLAB and statistics. Dr. Martinez was elected as a Fellow of the American Statistical Association (ASA) in 2006 and is an elected member of the International Statistical Institute. She was honored by the American Statistical Association when she received the ASA Founders Award at the JSM 2017 conference. Wendy is also proud and grateful to have been elected as the 2020 ASA President.

**Madhu Mazumdar** is Director of the Institute for Healthcare Delivery Science at the Mount Sinai Health System and Professor of Biostatistics at the Center of Biostatistics, Department of Population Health Science and Policy. She also directs the Biostatistics Core of the Tisch Cancer Institute. Dr. Mazumdar developed methodologies for detecting publication bias in meta-analysis; for adjusting selection bias in clinical trials; for allowing interim looks at data in clinical trials comparing diagnostic tests; for developing and validating quality of life questionnaires; and for estimating misclassification rates of responders when oncologic response criteria were changed. Her collaborative research resulted in personalized treatment regimens for various cancer types and orthopedic surgeries. Her work also changed guidelines for staging cancer and practice guidelines for use of anesthetics. She developed innovative interdisciplinary educational and research programs, in collaboration with various clinical departments that increased productivity through grantsmanship and augmented clinical revenue through improved care delivery. Working within interdisciplinary teams, she has trained more than 50 biostatisticians, epidemiologists, and clinical researchers, many of whom are leading quantitative science units today.

**Mary C. Meyer** holds the position of professor at Colorado State University. She received her PhD from the University of Michigan and spent 9 years at the University of Georgia. Her main research interests involve developing methodologies for statistical models with inequality constraints, such as arise from shape or order restrictions.

**Brian A. Millen** is a Senior Director within the Global Statistical Sciences (GSS) organization at Eli Lilly and Company (Lilly). In this role, he provides strategic leadership to the teams of statistical scientists whose applications and expertise in real-world analytics, health economic modeling, and clinical statistics enable formulary decisions and patient access to treatments. Dr. Millen's career with Lilly spans over 19 years in various technical and leadership roles within GSS and Advanced Analytics, including past Senior Director for the teams of clinical statisticians in

Lilly's neuroscience therapeutic area and as Senior Research Advisor providing statistical consulting and conducting statistical methods research. Dr. Millen has worked to advance diversity and inclusion (D&I) throughout his academic and professional careers. At Lilly, Dr. Millen has spearheaded Lilly's involvement in multiple diversity-focused initiatives and served on the D&I Council for Lilly Research and Development. At a national level, Dr. Millen regularly contributes as an invited speaker at events which encourage members of underrepresented groups to consider STEM careers. Notably, he established the JSM Diversity Workshop and Mentoring Program, a career development/mentoring program for minority statisticians, which has now served the profession for over 10 years. Dr. Millen is a Fellow of the American Statistical Association. He holds a Ph.D. in Statistics from the Ohio State University and a B.A. in Mathematics from the University of Georgia.

**Craig A. Molgaard** was born and raised in Iowa in a Danish-American community. After serving in the U.S. Army, he attended Iowa State University majoring in anthropology, where he graduated with honors and was Phi Beta Kappa, and carried out research in India and Thailand as part of the university SPAN (Student Project for Amity Among Nations) program. He then attended UC Berkeley, earning a Ph.D. in anthropology and an M.P.H. in epidemiology. His first faculty position was as a research associate in the department of medical statistics at the Mayo Clinic. Later he was appointed professor and director of the epidemiology program at San Diego State University, then was professor and chair of the Department of Preventive Medicine at the School of Medicine-Wichita at the University of Kansas, and then was professor, department chair, and director of the public health program at the University of Montana. He has held visiting positions at the University of Oxford and Roskilde University in Denmark. He currently is professor and co-director of the program in Rural and Global Public Health at the Fay W. Boozman College of Public Health at the University of Arkansas for Medical Sciences in Little Rock.

**Reneé H. Moore** earned a Bachelor of Science degree in mathematics and completed the secondary mathematics education program at Bennett College in Greensboro, NC. Dr. Moore earned her PhD in Biostatistics from Emory University. After completing her doctoral degree, Dr. Moore was an Assistant Professor at the University of Pennsylvania, Perelman School of Medicine, with a primary appointment in the Department of Biostatistics and Epidemiology and a secondary appointment in the Department of Psychiatry. Dr. Moore taught physicians, was the lead statistician in the data coordinating center for a multi-site randomized clinical trial investigating surgery as treatment for childhood sleep apnea (NEJM 2013), and was the biostatistician in the Center for Weight and Eating Disorders. Following that, Dr. Moore became an Associate Professor at North Carolina State University where she taught seven classes a year and continued her collaborations in obesity. Dr. Moore returned to Emory University in September 2015 as a Research Associate Professor and Director of the Biostatistics Collaboration Core. Dr. Moore is a Fellow of ASA, current ENAR treasurer, and remains very active with the ENAR

Fostering Diversity in Biostatistics Workshop and StatFest of the ASA Committee on Minorities in Statistics.

**Edward Mulrow** is Senior Vice President and Director of Statistics and Data Science for NORC at the University of Chicago. Ed has over 30 years of statistical consulting experience, which includes area probability sampling, tax compliance sampling, utilizing administrative records and other secondary data sources, Bayesian methods, evaluation methods, geographic information systems, visualization, data mining, record linkage, and performance measurement comparisons for determining parity. He earned a PhD from Colorado State University and is an Accredited Professional Statistician™ and Fellow of the American Statistical Association. In his current role at NORC, he leads a number of projects for government and nongovernment clients, such as the Centers for Medicare and Medicaid Services (CMS), the National Center for Health Statistics (NCHS), the Department of the Interior (DOI) Office of Historical Trust Accounting, and the Internet Corporation for Assigned Names and Numbers (ICANN). Prior to joining NORC Mulrow was a Director in the National Economic Consulting Group, Washington National Tax Services, PricewaterhouseCoopers LLP, and prior to that was a Senior Manager in the Quantitative Economics and Statistics Group at Ernst & Young LLP.

**Adriana Pérez** is Professor in the Department of Biostatistics and Data Science, the University of Texas Health Science Center at Houston, School of Public Health, Austin campus. She received her Bachelor's degree in Statistics from the National University of Colombia and her M.S. and Ph.D. degrees in Biostatistics from Tulane University. Dr. Pérez has engaged in a wide range of research projects: theoretical model evaluation accounting for imputation uncertainty, fitting complex data, analysis of cluster randomized community trials, clinical trials, analysis of food intake involving measurement error, and tobacco regulatory science. Dr. Pérez has over 100 publications. Besides her interest in Biostatistics she is interested in promoting diversity in our field and fostering recruitment, retention, and promotion of minorities in statistics. Dr. Pérez is an active member of the International Biometric Society (IBS) and the American Statistical Association (ASA). She has held numerous elected positions in several professional organizations including ENAR's diversity workshop, ASA Committee on Minorities in Statistics, and IBS. She has served as an organizer member of the StatFest conference since 2016, including hosting StatFest in 2019 seeking to increase the diverse workforce in statistics in our country. In 2019–2020, Dr. Pérez served as Faculty chair in her institution.

**Nancy Fagenson Potok** has over 35 years of executive management experience in the public, private, and nonprofit sectors. She has served as Chief Statistician of the United States in the Executive Office of the President; Deputy Director and COO of the U.S. Census Bureau; Deputy Under Secretary for Economic Affairs at the U.S. Department of Commerce; Senior VP for Economic, Labor, and Population Studies at NORC at the University of Chicago; and COO at McManis & Monsalve

Associates, a business analytics and organizational transformation firm. She is President of NAPx Consulting, LLC. Dr. Potok is a Non-Resident Fellow at the Urban Institute, Fellow of the National Academy of Public Administration, Chair of the Board of Trustees at the Institute of Pure and Applied Mathematics (IPAM) at UCLA, a contributing editor to the *Harvard Data Science Review*, on the Board of Visitors for the School of Information and Computer Science at the University of Pittsburgh, and on the Board of the Data Foundation. She is the recipient of the Presidential Rank Award, Secretary of Commerce Gold and Silver Medals, Arthur S. Flemming Award, and was named to the Federal 100. She received her Ph.D. at the George Washington University.

**Sanita Šaitere** received her PhD in psychology in 2012 from the University of Latvia in Riga, Latvia, and is a lecturer of work and organizational psychology at the University of Latvia since 2013. Dr. Šaitere is a certified work and organizational psychologist and an experienced human resource professional, practicing in human resource projects involving personnel recruitment, selection, assessment, development, work-life balance, motivation, and job analysis. She holds an active role in the Latvian community of psychologists, being a member of the board of the Latvian Society for Organizational Psychology, and is a member of the executive council of the Latvian Society of Psychologists.

**Allan R. Sampson** (1945–2021) was Professor of Statistics at the University of Pittsburgh. He received his bachelors in mathematics from UCLA, his master's in statistics at Stanford University, and his PhD in statistics from Stanford University under Ingram Olkin. His research interests included multivariate analysis, clinical trials, order-restricted inference, reliability, applications in biopharmaceutics, psychiatry and medicine, and stereology. His work included designing adaptive clinical trials where the design can be modified based on intermediate data; statistical models and methods for neurobiology; dose response methodology; biopharmaceutical clinical trials and regulatory agencies; order-restricted methods in statistical models; and multivariate modeling. Dr. Sampson was named a Fellow of the American Statistical Association, a Fellow of the Institute of Mathematical Statistics, and a Fellow of the American Association for the Advancement of Science.

**Jaya M. Satagopan** is Professor of Biostatistics and Director of the Center for South Asian Quantitative Health and Education at Rutgers School of Public Health and Rutgers Cancer Institute of New Jersey. Dr. Satagopan conducts research in the area of statistical genetics/genomics with applications in cancer and cancer-related outcomes. Her research topics include cost-effective study designs for genome-wide studies, estimating the lifetime risk of cancer in mutation carriers, dimension reduction and Bayesian shrinkage analysis methods for evaluating multiple disease risk factors, and methods for evaluating gene-exposure interactions. She applies these research works in various collaborative studies of cancer epidemiology and tumor biology to examine the distribution of cancer risk and genetic, environmental, and lifestyle determinants of this distribution. She has provided summer training to over 15 high school, undergraduate, and graduate students on the applications of

statistical approaches in cancer, many of whom are either pursuing higher education in quantitative sciences or engaged in quantitative professions at leading industries today. She has also organized symposia on statistical methods in cancer genetic epidemiology that brought together junior and senior researchers to engage in dialogues and collaborations on translational cancer research.

**Sandra Sebre** is a professor of psychology at the University of Latvia in Riga, Latvia, where she teaches courses on developmental, clinical, and health psychology. She holds master's degrees from Harvard University, Columbia University, and a PhD from City University of New York in 1992. She came to Latvia in 1994 on a grant from the Social Sciences Research Council and was offered the opportunity to assist in the development of the first psychologists' training program in Latvia, since prior to the restoration of the independence of Latvia in 1990, there were no such programs. She was initially director of the master's degree program in psychology at the University of Latvia, and later for 8 years served as chair of the department. In parallel she participated in the drafting of the first versions of the Psychologists' Law and the Professional Standard for Psychologists in Latvia. Her research interests include socioemotional development across the life span, cross-cultural comparisons, empathy and tolerance, and narrative identity. She is a member of the Latvian Society of Psychologists and the European Association of Psychological Assessment.

**Ellen Sim Snyder** is a Senior Principal Scientist in Biostatistics and Research Decision Sciences at Merck & Co., Inc. She has been with Merck for over 26 years. She has worked in Late Development Statistics as a statistician or statistical team leader on the design and analysis of clinical trials for new drug applications in the areas of gastroenterology, ophthalmology, infectious disease, oncology, and neuroscience. She is currently in Clinical Safety Statistics where her focus is on characterizing the program-level safety profile of compounds in development and innovative statistical methodology and processes for monitoring the safety of products throughout their life cycle. Prior to Merck, Ellen also worked as a Research Associate in Clinical Epidemiology at the University of Pennsylvania School of Medicine, where she taught statistics to postdoctoral medical fellows and collaborated on grants and epidemiologic studies. Ellen has had a productive career as a statistician, lecturer, and collaborator with over 100 journal articles and abstracts in the medical and statistical literature. She earned her M.S. and Ph.D. degrees in Biostatistics from the University of North Carolina at Chapel Hill. Ellen is a member of the American Statistical Association (ASA), ASA Biopharmaceutical Section Safety Working Group, and Sleep Research Society.

**Ieva Stokenberga** received her PhD in psychology in 2010 from the University of Latvia in Riga, Latvia, and has recently been appointed as chair of the psychology department at the university. She has held the position of assistant professor since 2012 and teaches courses in personality psychology, communication skills, and health psychology for undergraduate and graduate students. Her research interests and professional activity are primarily focused on individual resources

for health promotion and well-being. She continues to participate in national and international research collaborations on the study of the sense of humor. More recent research topics include occupational health psychology and individual differences in burnout. Ieva Stokenberga is a certified work and organizational psychologist and an experienced trainer on communication skills and social emotional competence. She actively participates in Latvia's leading NGO devoted to health promotion and is a member of the Association of Latvian Young Scientists and the Latvian Society of Psychologists.

**Brian Tarran** is editor of *Significance* ([significancemagazine.com](http://significancemagazine.com)), the magazine of the Royal Statistical Society and the American Statistical Association. A journalist by training, he began his career working as a reporter for local newspapers in east London before moving into magazines. Before joining *Significance* in June 2014, he was launch editor of the Market Research Society's award-winning quarterly magazine, *Impact*.

**Jessica Utts** is a Professor Emerita in the Department of Statistics at the University of California, Irvine. She has held multiple leadership positions in professional organizations, including 2016 President of the American Statistical Association (ASA), President of the Western North American Region of the International Biometric Society (WNAIR), Chair of the Committee of Presidents of Statistical Societies (COPSS), President of the Caucus for Women in Statistics, and Vice-Chair of the Board of the National Institute of Statistical Science (NISS). She has held terms on the Councils of the International Statistical Institute and the American Association for the Advancement of Science (AAAS). She is a Fellow of the ASA, the Institute of Mathematical Statistics (IMS), the AAAS, and the Association for Psychological Science. She is the recipient of the ASA Founder's Award, the IMS Harry C. Carver Medal, the NISS Distinguished Service Award, and two awards for distinguished teaching. She has a long-standing interest in promoting statistical literacy and has published three statistics textbooks. In addition to statistics education her research involves applications of statistics to a variety of areas, most notably parapsychology, for which she has appeared on TV shows including Larry King Live, Nightline, and CNN News.

**Nora Vele** is the Executive Director of Global Diversity & Inclusion for Merck. She provides strategic direction on all aspects of the company's equal opportunity and affirmative action programs. She also leads Merck's Disability & Inclusion Ambassador Team, a cross-functional group of leaders focused on inclusivity for individuals with disabilities which helps to support the organization's diversity and inclusion strategy. Nora has over 25 years of demonstrated expertise in developing cutting-edge programs, design of metrics, measurement tools, and change efforts related to equity and inclusion. Nora has represented industry in discussions with federal agencies to provide an employer perspective and share best practices on implementation of regulations into diversity and inclusion programs. Nora is a member of the New Jersey Supreme Court Committee on Diversity, Inclusion, and Community Engagement. She previously served on the Board of Directors for the

Center for Workplace Compliance and the International Labor Organization Global Business and Disability Network. She has been named as one of Black Enterprise's Top Executives in Global Diversity and Inclusion and the recipient of the Lois Baumerich Lifetime Achievement Award, a coveted recognition for a life's work of promoting equal opportunity and affirmative action in employment.

**Bin Yu** is the Class of 1936 Second Chair in the College of Letters and Science, and Chancellor's Distinguished Professor, Departments of Statistics and of Electrical Engineering & Computer Sciences, and Center for Computational Biology, University of California at Berkeley. She is a Chan-Zuckerberg Biohub Investigator and a former chair of Statistics at UC Berkeley. Her research focuses on practice, algorithm, and theory of statistical machine learning and causal inference. Her group is engaged in interdisciplinary research with scientists from genomics, neuroscience, and precision medicine. She is a member of the U.S. National Academy of Sciences and a fellow of the American Academy of Arts and Sciences. She was a Guggenheim Fellow in 2006 and the Tukey Memorial Lecturer of the Bernoulli Society in 2012. She was President of IMS (Institute of Mathematical Statistics) in 2013–2014 and the Rietz Lecturer of IMS in 2016. She received the E. L. Scott Award from COPSS (Committee of Presidents of Statistical Societies) in 2018. Moreover, she was a founding co-director of the Microsoft Research Asia (MSR) Lab at Peking University and is a member of the scientific advisory board at the UK Alan Turing Institute for data science and AI.

**Gideon K. D. Zamba** received his B.S. in Pure Mathematics in 1994 and his M.S. in Applied Mathematics from the University of Lomé in 1995—with focus on optimization and numerical analyses. He completed his M.S. and Ph.D. in Statistics in 2003 at the School of Statistics, University of Minnesota. He is currently a Professor of Biostatistics at the University of Iowa (UI) and holds a secondary appointment as Professor of Radiology and Nuclear Medicine. His methodological research specializes in change point theory, dynamic processing, sequential analysis, computational statistics, multivariate statistics, syndromic surveillance, and recurrent events analyses in reliability. He is a consultant in the UI Biostatistics Consulting Center and statistician in the UI Holden Comprehensive Cancer Center. He collaborates with medical researchers in Ophthalmology, Radiology, Neurology, and Nuclear Medicine. His collaborative research includes cancer, emphysema, glaucoma, and influenza. He is a co-founder and Director of the Iowa Summer Institute in Biostatistics (ISIB). As architect of ISIB, his work has been pivotal in designing the program and building academic relationships with regional colleges and minority institutions. Dr. Zamba is a founding member of the statistical research unit of the International Society for Disease Surveillance and currently an Associate Editor for *Sequential Analysis*.



**Part I**  
**Opportunity for the Profession**

# The Changing Culture of Statistics and Data Science: A Vision for the Profession



Amanda L. Golbeck and Craig A. Molgaard

**Abstract** Do you want to improve the professional climate, environment, or culture of your workplace? Here are some basic concepts—diversity, equity, inclusion, inclusive leadership, and culture change—that will help you and other statisticians, data scientists, or STEM colleagues to plan for inclusive excellence.

## Introduction

The profession of statistics and data science is becoming more diverse, more equitable, and more inclusive.

There are many signs of progress. It is no longer unusual for the president of the world's largest statistical association, the American Statistical Association (ASA), to be a woman. Nor is it unusual for the president of the Caucus for Women in Statistics, which is independent of any statistical association, to be an Asian American. Nowadays you can open the Joint Statistical Meetings (JSM) *Registration Guide* and expect to see pictures of people from different social categories. When you get to the JSM you can go to hear a lecture named after a woman: The F.N. David Lecture or the Elizabeth L. Scott Lecture, given in alternating years. More and more African Americans are following in the footsteps of the great statistician David Blackwell. There is a new statistical association in Europe, the Croatian Statistical Association, which is facilitating productive partnerships among statisticians from the Balkan region where there have been challenging historical relationships. The worldwide statistics association, the International Statistical Institute, in 2017–2019 had its second woman president, after being founded in 1885.

When a person is in the thick of leading change, it is easy to see the glass as half empty, and culture change can seem inordinately slow. This is why it is good to periodically take a pause, breathe deeply, and take stock. Most of the changes in the

---

A. L. Golbeck (✉) · C. A. Molgaard  
University of Arkansas for Medical Sciences, Little Rock, AR, USA  
e-mail: [agolbeck@uams.edu](mailto:agolbeck@uams.edu); [CAMolgaard@uams.edu](mailto:CAMolgaard@uams.edu)

given examples have taken place in a relatively short period of time, since 2010. The amount of change that has taken place across the decade is notable and suggestive that the field of statistics and data science has the capacity to consider, act upon, and accelerate the championship of diversity, equity, and inclusion (DEI) as core values.

It will be important that our consideration of DEI be thoughtful, where we fully examine its dimensions. The debates that have happened and are happening in our profession about DEI, such as whether a prominent Committee of Presidents of Statistical Societies (COPSS) lecture should continue to be named after a brilliant statistician who was a eugenicist, are healthy. Such debates promote reform. As reasonable people carry out this exercise, we can expect to identify elements that are clear, as well as elements that are less clear. We can expect points of agreement, as well as points of less agreement. In any case, the Big Tent of statistics, which the ASA has recently used as an image to welcome people across all sectors of statistics and data science workplaces (business/industry, government and academic), is now poised to more fully welcome people across other dimensions of diversity.

In this chapter, we explore some ideas that are fundamental to the understanding of inclusive excellence. These include values, diversity, equal opportunity, equity, inclusion, inclusive leadership, and culture change. We hope that our synopses and vignettes will be useful to statisticians and data scientists.

## Values

Leaders in all workplace sectors are embracing DEI as actionable values.

The buy-in of the academic sector to DEI is especially easy to see. Just look at the job vacancies listed in *The Chronicle of Higher Education*. *The Chronicle* is one of the primary places that lists, for example, employment opportunities for the position of provost or vice president for academic affairs at colleges and universities across the United States and beyond. Eleven of such positions were listed in a recent online edition of *The Chronicle*, and all but one included DEI as a qualification (the exception being a military-affiliated institution). Elaborations of DEI qualifications included some of the following kinds of elements:

- Demonstrated or firm commitment to (increasing) diversity, equity, inclusion, access, or affirmative action;
- Demonstrated understanding of, or track record of working with, diverse student, faculty, and staff populations;
- (Ability to) strategically guide, create, build or foster through the creation of programs and services a well-qualified, culturally diverse, pluralistic or international faculty; and
- Commitment or demonstrated strength in creating or supporting a respectful and inclusive workplace, educational environment, or community.

A University of Arizona ad for a Senior Vice President for Academic Affairs & Provost included the “why”: “*The University of Arizona values its inclusive climate because diversity in experiences and perspectives is vital to advancing innovation, critical thinking, solving complex problems and creating an inclusive academic community.*” (*The Chronicle of Higher Education*, 12/28/2018).

Some might say that higher education is obsessed with DEI. A broad scan of job ads indicates that colleges and universities are looking for many categories of employees who have DEI values. For faculty members, in particular, diversity statements are frequently being required in their applications for employment and files for tenure and promotion. While such practice has been criticized by some as being overly political and perhaps even a litmus test, proponents see diversity statements as a way to help institutions carry out their missions to serve all people with fairmindedness and integrity (Hampton, 2020).

It is the norm in the academic sector to employ chief diversity officers. The sector of business and industry is increasingly following suit. Already by 2019, over 47% of S&P 500 indexed companies had chief diversity officers (McGirt, 2019). These companies are embracing DEI values as organizational imperatives. They are taking up the challenging and increasingly essential work that can eventually help to transform our workplaces and the world.

(Golbeck)

I received a bachelor’s degree from Grinnell College in Iowa in 1974. Grinnell is a highly ranked liberal arts college with a long-standing commitment to DEI. I remember visiting there as an alumna in the 1990s and realizing the strength of that commitment as I looked around the campus. African American art filled the walls of the main corridors in the lower level of The Forum (student center). Books by authors from groups underrepresented in higher education (particularly African American, American Indian, and Latinx) filled the windows of The Grinnell Bookstore. In 2010, Grinnell appointed a black openly gay president, Raynard S. Kington, who was previously the deputy director and acting director of the National Institutes of Health.

The *Grinnell Magazine* comes to my house every quarter. The Winter 2018 edition included an article about how the college was investing in diversity and inclusion. It was written by Kington who asked: How do we give diverse students the best chance to develop and succeed? He explained that part of the answer is to create spaces where they can “respectfully discuss issues of difference and incorporate the values of diversity and inclusion into their academic and extracurricular lives from day one.”

Kington noted that the faculty play an indispensable role in the process of building a community “of differing perspectives, opinions, backgrounds, identities, and experiences working side by side in a peaceful yet challenging environment.” He explained that the “challenging, sometimes imperfect, but increasingly essential” diversity and inclusion work can create the “open-minded, flexible, driven, courageous, and bold global citizens our world will need in the decade ahead” and “can eventually transform the world.”

(Molgaard)

I attended Iowa State University (ISU) at Ames, Iowa, graduating in 1974. My diversity experience there began when I joined the Student Projects for Amity among Nations (SPAN). This program was begun in 1961, with the opening of a campus office, and the sponsoring of a first group of undergraduate students from ISU who traveled to England in 1964. The program focused on increased understanding and good will between countries, with a group of students selecting a country, studying it and its culture and language for a year, then going to that country for an intensive summer research project. This was followed

by writing up the research during the next year at ISU. It was modeled after a similar SPAN program at the University of Minnesota, where it was the oldest study and research abroad program at that university, existing since 1947.

In 1973 the Global Programs Office was opened in the College of Agriculture and Life Sciences at ISU. The SPAN program was moved into the Global Programs Office, but was mentored heavily at that time by Chalmer Roy, Dean of the College of Arts and Sciences, and a renowned geologist who carried out research in Iowa and India, after receiving his Ph.D. at Harvard. The SPAN program was preparing to send a group of students to India in the summer of 1973 (as well as Israel because of growth in the program), and I was tasked to approach Dean Roy to seek resources for the educational and linguistic training we needed to prepare for our trip to India. It was my first experience with mentoring.

As a first-generation college student, I had no idea of the immense personage I was about to seek support from, or how light his mentoring hand could be. "What's a Dean?" I thought as I knocked on his door.

He turned out to be one of the nicest people, and the most helpful one, I ever met. "You will need language instruction," he said to me. I said, "Yes, I found a woman who could teach us Hindi and is available next semester and has teaching experience." He gave me a nod of approval. "You will need money to pay her." I said, "Yes." "You will need to order books." I said, "Yes." "You will need a classroom." I said, "Yes." And we were off and running. He gently walked me to his door as we ended our conversation, and said in his absolutely correct but definitely Missouri accent, "Come back to me if you need anything else." He was always there for me.

So that's what a Dean is, I thought to myself as I walked down the steps of the Curtis building. They were a type of academic Santa Claus, trying to make programs happen. I wondered if they were always so polite and soft-spoken.

Our team leader and country guide for India was Dr. Rohit Trivedi, who taught Material Sciences and Engineering at ISU, where he was beginning a tremendous career, including among many other accomplishments, designing experiments for the International Space Station and working at the Ames Laboratory. He led us to Bombay (now Mumbai) and got us moving on our projects. I traveled to the village of Baswapur, north of Hyderabad, and began research on the Telegu speakers of Baswapur who were involved in rural-urban migration to work in the oil fields of Kuwait. The money they returned to the village from Kuwait was crucial to its local economy in a very underdeveloped part of India. Later I would write up my research as my SPAN project, which was also part of my undergraduate Honors Program Project.

My take-home message was that diversity was the rule rather than the exception in India, but that diverse groups could and did work together to accomplish their mutual goals. But like the mentoring of Chalmer Roy, such cooperation and partnership often occurred with a light hand.

## Diversity

Diversity is shorthand for a group of people who are not substantially alike.

Some argue that there is no single way to define diversity; diversity can mean different things to different people. Kington provided one definition when he explained why Grinnell College was investing in diversity and inclusion: Diversity is "... that which makes us different from each other, including who we are, where we're from, what we believe, who we love, our current circumstances, abilities, and lived experiences."

A priority population is a group of people who are substantially alike and who are designated by governments or organizations for focused attention and action. The United States Government names priority populations when it protects groups who have historically experienced exclusion or disadvantage in employment; these protections come in the form of equal-opportunity employment laws. Many academic units in the United States name priority populations when they identify groups who have historically been underrepresented or disadvantaged in the mix; the units develop goals for these groups in such areas as recruitment and retention.

Often these academic unit goals are overseen by accrediting agencies. For example, many statisticians are employed within, or are affiliated with, schools or programs of public health, which must meet standards established by the Council on Education for Public Health (CEPH). The CEPH accreditation standards include an entire section on Diversity and Cultural Competence (see G1 in the Accreditation Criteria at <https://media.ceph.org/documents/2016.Criteria.pdf>). Among other things, this section requires schools and programs of public health to self-define the populations they consider to be of major interest and importance and develop targeted goals for them. CEPH requires an explanation of why these populations were chosen and the process that was carried out to make the choices.

CEPH makes suggestions about possible choices of priority populations. They do not consider their list to be exhaustive. Priority populations can be different for students, faculty, and staff. For example, in their recent public health self-study, one university chose the same priority population (i.e., certain race ethnicities) for their student, faculty, and staff. However, they also chose an additional priority population for their students (i.e., first-generation college students).

Priority populations that are either protected by the United States government or suggested by CEPH are shown in the list.

### Priority Populations

- Age<sup>a</sup>
- Ancestry<sup>a</sup>
- Color<sup>a</sup>
- Creed<sup>a</sup>
- Disability that is unrelated to job requirements<sup>a</sup>
- Community affiliation
- Culture
- Ethnicity<sup>a</sup>
- Gender
- Gender identity
- Genetic information<sup>a</sup>
- Health status
- Historical under-representation
- Language
- Marital status<sup>a</sup>
- Maternity status<sup>a</sup>

National origin<sup>a</sup>  
 Race<sup>a</sup>  
 Refugee status  
 Religion<sup>a</sup>  
 Sex<sup>a</sup>  
 Sexual orientation<sup>a</sup>  
 Socioeconomic status  
 Veteran status<sup>a</sup>  
<sup>a</sup>Government-protected

It has been suggested that diversity also includes different ways of thinking, such as having different value structures. Using this broad perspective, diversity could mean, for example, inclusion of people from different employment sectors (business/industry, government, academe). For another example, it could mean inclusion of people from different disciplines on multidisciplinary teams. The important thing is that the people assembled are not substantially alike so that they can contribute different ways of thinking and hence add value to an endeavor.

(Golbeck)

My appreciation for cultural and linguistic diversity stems from my childhood. I loved reading folk stories about people from other lands, did a summer study abroad in Austria (where I learned about culture shock), and then went to college to study variation among people by concentrating on the fields of anthropology and statistics. I became a professor of mathematical sciences.

I was called to spend many years as an academic administrator working across disciplines. Then, in 2006, I left administration and “went forward” to the faculty and eventually began to participate again in statistics professional association activities. I went to a JSM and noticed that the pictures of featured lecturers did not include women; and then I noticed that the *JSM Registration Guide* did not contain pictures of women. (Golbeck, 2012). I am pleased to note that now the guide typically includes more diverse faces.

(Molgaard)

I did a summer abroad in India and Thailand, and then went to graduate school to study variation among how people communicate by completing a dissertation in linguistic anthropology. Did you know that the Sami people have 1,000 words for reindeer? However, my childhood experiences of growing up in a bilingual community (Danish) with bilingual parents also focused me on diversity (our community was surrounded by German, Swedish, and English settlers, so we were very aware of difference as an entity) and also on inclusion. For example, Danes are said to be the most “clannish” of the Scandinavian peoples. From my observations this is certainly true, driven by linguistic isolation and political events in Europe during the mid-1800s.

(Golbeck and Molgaard)

Both of us have worked in public health. It has been said that there is no one path to the field of public health. Our leadership in this inherently interdisciplinary field has reinforced for us the value of solving complex and sticky research problems by assembling teams of people who are not substantially alike by training or background. In our experience, thinking about things from different angles and positions drives better and faster solutions.

## Equal Opportunity

Equal opportunity is the principle of not discriminating against individuals because they are members of certain populations.

When equal opportunity prevails in employment, everyone is able to compete on equal terms. There is a level playing field.

Many policies have been adopted by individual academic institutions to help ensure equal opportunities for faculty, staff, and students as pertain to recruitment, retention, development, career advancement, and access to resources. Thanks to statistician Elizabeth L. Scott and other academic equal-opportunity trailblazers, women are now admitted to graduate programs and offered fellowships based on their academic qualifications, in equal competition with men; conflict-of-interest rules have replaced nepotism rules, which permit academic spouses, who are often in the same field, to work in the same academic departments; women are allowed to be principle investigators on extramural grants in their own names rather than being fronted by a male; and women are allowed to be members of university faculty clubs that historically were only open to men. These and other gains happened in the late 1960s and across the 1970s (Golbeck, 2017).

Over the years, there have been some important studies in the peer-reviewed literature that illustrate lack of equal opportunities in employment for people of different genders and races/ethnicities. One looked at well-known male scientists and the gender of graduate students who worked in their laboratories. They discovered the men were training a smaller proportion of women as compared to the proportion of women in the overall graduate student population. Another study looked at African American versus white-sounding names when people were applying for jobs. They discovered that people with African American-sounding names had to submit more resumes before receiving a call back. Yet another study compared resumes with a man's name versus a woman's name that were submitted for a lab manager position. They discovered that resumes with a woman's name got less positive feedback and lower projected salary offers. In recent years, institutions have adopted many other policies that address equal employment opportunity searches, discrimination, discriminatory harassment, sexual harassment, reasonable accommodation, etc. An example is that there are now rules where musicians audition for symphony orchestras while shoeless and sitting behind a screen; this way, judges can judge based solely on the music, rather than allowing for possible bias due to the sound of the person's shoes or the way the person looks (Golbeck et al., 2016).

(Golbeck)

I experienced inequity of opportunity at an early age by growing up in a household with strict gender norms. These norms dictated that boys took out the trash every 3–4 days, and boys sat in the front seat of the car; girls dried the dishes after every meal (we didn't have automatic dishwashers in those days), and girls sat in the back seat of the car. When I asked my parents why boys and girls were treated differently, I was told it was because boys were boys and girls were girls. This was even though boys are capable of drying dishes and sitting



in the back seat of the car, and girls are capable of taking out trash and sitting in the front seat. These experiences of lack of equal opportunity were seeds that many years later led to my advocacy for academic women, including women in statistics and data science.

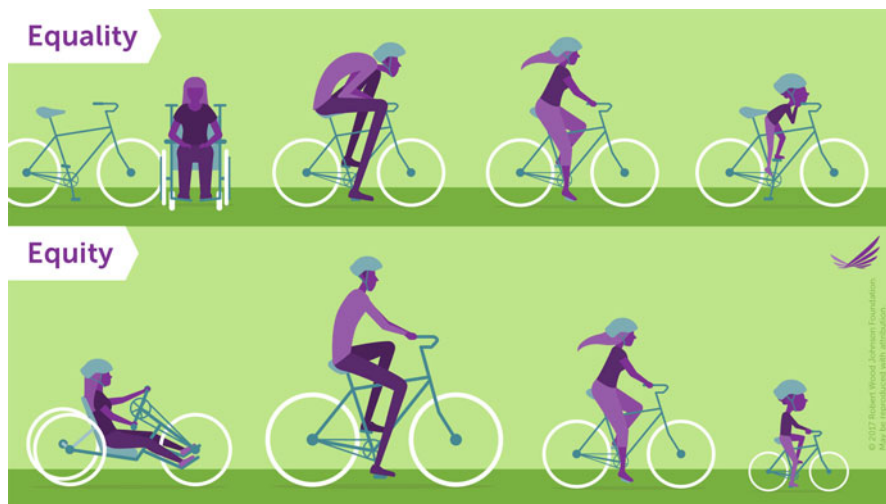
(Molgaard)

I experienced inequity of opportunity by growing up in a rural community where land ownership (owning the farm you worked) rather than renting guaranteed enhanced acceptance by the other farmers and urban dwellers. Renting, even if renting a large farm, was stigmatized in terms of social roles and social mobility, economic possibilities, and professional and educational training opportunities. This was especially the case for the children of renters, who then would continue the cycle of stigma unless they were able to move to a large city and find training for a new job (favorites were Minneapolis and Omaha). My own escape was navigated through serving in the U.S. Army and receiving the educational benefits of the G.I. Bill.

## Equity

Equity is the fairness that comes from the facilitation of equal opportunity.

Equity and equality are often mistaken to be synonyms. There are some wonderful infographics on the web that illustrate how equity and equality are different. The figure below is one that we especially like. It is made available by the Robert Wood Johnson Foundation (<https://www.rwjf.org/en/library/infographics/visualizing-health-equity.html>). Notice that with equality, everyone has the same size bike. But the same size doesn't work for everyone. The person in the wheelchair needs a recumbent bike. The man is too big, and child too small for the standardized bike. With equity, everyone gets a bike that fits them. Everyone has equal opportunity to ride.



Put simply, equity involves giving more or something different to those who need it to level the playing field. Equity recognizes that we don't all have the same advantages and disadvantages, and that some of the disadvantages arise from things beyond our control like social identities or physical impairments. Equity requires an understanding that there are inequalities or impairments at the starting line, along the racetrack, and at the finish line. Equity is a commitment to leveling the playing field so that everyone has a chance to succeed.

An example of equity is that we now have academic policies for more flexible tenure ladder appointments, recognizing that women can be both mothers and academics. Another example is that there are now rules that require organizers of invited sessions at microbiology professional association meetings to include women in the sessions; in this way, women are ensured to be among the panelists and speakers (Golbeck et al., 2016).

Much more needs to be done. The United States Office of Educational Development states that: "The challenge of ensuring educational equity is formidable." (<https://www.ed.gov/equity>). We would add that the challenge of ensuring workplace equity is equally formidable. It would be great to see more statisticians and data scientists engaged in future studies of educational and workplace equity.

(Molgaard and Golbeck)

While in middle school, our son fell during gym class and shattered his left knee. He could only continue in school from a wheel chair that would provide him with accommodation for eleven weeks. Every day the school bus stopped in front of our country home and we brought him out to the side of the bus where an elevator scooped him up and deposited him in the bus. It would take him to school where he would be unloaded and a designated classmate wheeled him to his classroom. This went on all day until the bus brought him home. For him, and us, this was a form of equity, which allowed him to finish the school year and not fall behind his classmates. Moreover, the care that was taken on behalf of our son by others was an act of kindness.

## Inclusion

Inclusion is how we maximize the channeling of value from unique individuals into the collective whole.

This notion comes from the USA Today Career Network, which tells us that: While "Diversity is who we are, and Equity is how we operate", "Inclusion is what we do." (<https://usatodaynetworkcareers.com/inclusion/>). The Society for Human Resource Management defines inclusion as "the achievement of a work environment in which all individuals are treated fairly and respectfully, have equal access to opportunities, and can contribute fully to the organization's success." ([www.shrm.org](http://www.shrm.org)).

Inclusion creates a dynamic among diverse people; it embraces how each unique individual cogitates, communicates, and adds value. The premise is that inclusion will benefit the enterprise: By incorporating and channeling all of this unique individual value, the value of the collective can be maximized. The idea is that

inclusion of all perspectives will challenge insularity, permit deep discussions, and will thereby stimulate breakthroughs and progress.

Inclusion also benefits the individual. Who doesn't want to be treated as a valuable and respected member of a collaboration? Who doesn't want to be empowered to contribute to the range of solutions? Inclusion results in people being who they are at work and feeling comfortable and of value in their jobs. The promise is that this will not only result in employees who will stay, but in ones who will go above and beyond in their jobs.

Focusing on diversity at the expense of inclusion will likely lead to disappointment. It can result in putting people in boxes where they are disconnected and marginalized. Also, everyone in the organization needs to embrace inclusion or there will be disappointment. The chief diversity officer alone cannot create and sustain an inclusive organizational environment.

(Golbeck and Molgaard)

We like to listen to jam band music. The musicians on the stage typically play songs that they have played before, but they never play them exactly the same way. There is a lot of innovation and experimentation. For example, a 7:38 minute studio version of a song could evolve into an uninterrupted 46-minute jam when performed live. Or a song can evolve into a different song and then cycle back into the original song.

We like being in the audience to watch this creation happen, and the musical dynamics regularly transport us to new places in our imaginations. We want to go back for more, and so we often travel distances to attend jam band concerts. We try to attend more than one consecutive night to hear the same band, because each night's rendition is unique.

If you read descriptions about how the jam band artists accomplish such great music on the fly, they typically say it involves assembling a group of talented individuals who have different musical personalities. Once assembled, the individuals have to learn to trust each other and be willing to actively converse musically, bring in new musical ideas, and share the space of the music by taking turns.

Jam band guitar virtuoso Tommy Hamilton (of Ghost Light and Joe Russo's Almost Dead) has the same philosophy for music and life: "With anything, if you put the same—ingredients into something, you'll never get different results . . . I feel like whether that is a social circle, social platform, music . . . it's about the variety. It's about doing different things. If you think the opposite of me, we should at least have conversations. Interesting things might come out of that . . . if everyone is working with the same confines, then everyone is going to sound the same. What . . . is the point of that?" (Krikland, 2018).

The more we learn about the philosophy of jam bands, the more we understand another reason why we like this music so much. It is music that generates from, and is nourished by, DEI. It translates to our lives and professions. It gives us a clear vision for our professions, that statistics, data science and public health workplaces are jam bands . . . a vision for them to be models of DEI among the sciences.

(Golbeck)

I am currently the associate dean for academic affairs at a college of public health. At an earlier time, I was the associate dean for undergraduate studies at a comprehensive university that had 25,000 undergraduates. This position involved, among other things, responsibility for all university-wide DEI programs.

The most significant among these was a faculty-student mentoring program funded by the state of California. This program aimed to increase the retention of students from groups historically underrepresented in higher education (particularly African American, Latino/a, and American Indian). The primary mechanism of accomplishing the aim was through inclusion.

There was an implementation of the program in each of the university's eight colleges. The distinctive implementations recognized the diversity of academic styles and approaches across the colleges. There was a multilevel approach in each college. A faculty mentor recruited student mentors from among the upper-division students and then supervised them. The mentors developed creative and targeted programming to address the academic and social needs of the mentees. The group activities were intended to create a sense of community and a safe space to discuss sensitive issues. The larger objective was to provide an inclusive environment that would in the short term boost the retention of these students and in the longer term boost their careers.

(Molgaard)

For ten years, I was chair of a new Master of Public Health (MPH) program in Montana. There were a host of public health problems and issues in the state. Many of these were part and parcel of the American Indian reservation system, which contained 7% of the Montana population, making it the largest minority population. There were a number of reservations in the state.

So how were we to benefit the American Indians? First, we had to include them in all aspects of our activity, and then we had to retain them. (The desire to leave the program and return to the reservation was common among the young American Indians). Although seven different tribes lived on these reservations, we treated them as our primary minority group, that is, we treated them the same, but special and equal.

Eventually we convinced CEPH, our national accrediting agency, that Montana had a special minority population. After the first two years of the program our American Indian enrollment surpassed the state percentage of seven percent, and the American Indians carried out superb and nationally recognized public health research.

## **Inclusive Leadership**

Inclusive leaders make DEI work.

Leadership can be defined as influence, toward a goal. Inclusive leadership, then, is influence that takes place within an environment that the leader has fostered to be inclusive. Inclusive leadership is a complex topic, with many nuances.

At a fundamental level, inclusive leadership recognizes that people work in teams to achieve organizational goals. In other words, people collaborate in the workplace. Inclusive leaders are intentional about creating environments where diverse people are represented on the team and team members feel comfortable to express themselves. They are good at listening to others and at facilitating team discussions. They recognize that everyone on the team has backgrounds and perspectives that should be heard because hearing many ideas (even ones that turn out to not be very useful) will help to identify a best idea. Successful statisticians and data scientists are masters at working on teams and collaborating.

There is evidence that sustained deliberate effort and energy toward inclusive leadership will result in collaborations that are highly productive. A recent study reported in the *Harvard Business Review* found that: "Teams with inclusive leaders are 17% more likely to report that they are high performing, 20% more likely to say they make high-quality decisions, and 29% more likely to report behaving

collaboratively. What’s more, we found that a 10% improvement in perceptions of inclusion increases work attendance by almost 1 day a year per employee, reducing the cost of absenteeism.”

The research further identified the following six signature behaviors of inclusive leaders: “(1) *Visible commitment*: They articulate authentic commitment to diversity, challenge the status quo, hold others accountable and make diversity and inclusion a personal priority. (2) *Humility*: They are modest about capabilities, admit mistakes, and create the space for others to contribute. (3) *Awareness of bias*: They show awareness of personal blind spots as well as flaws in the system and work hard to ensure meritocracy. (4) *Curiosity about others*: They demonstrate an open mindset and deep curiosity about others, listen without judgment, and seek with empathy to understand those around them. (5) *Cultural intelligence*: They are attentive to others’ cultures and adapt as required. (6) *Effective collaboration*: They empower others, pay attention to diversity of thinking and psychological safety, and focus on team cohesion.” (Bourke & Espedido, 2019).

Inclusive leaders exercise these behaviors each and every day. They pay attention and listen hard to what others say and do; they pay a great deal of attention to what they themselves say and do; and they intentionally create space for and involve diverse people.

(Golbeck)

I previously held the position of vice president for academic affairs for a state post-secondary educational system comprising seven universities (including the University of Kansas and Kansas State University) and 29 community colleges and technical institutions. There were a number of advisory councils to the board of regents comprising representatives of the 36 institutions: Councils of presidents, vice presidents for academic affairs, vice presidents for finance and administration, faculty senate presidents, and student council presidents.

This was a great place to practice inclusive leadership. We needed to find win-win system-wide solutions for all kinds of big and complex issues, e.g., for

- shifting to performance-based institutional funding;
- providing degree program access to residents of all quadrants of the state;
- incorporating community colleges and technical institutions into a coordinated system;
- establishing a digital learning advisory board for postsecondary education;
- developing definitions of degrees that were acceptable to all sectors (university, community college, technical institution);

and the like. Success of the vice president for academic affairs intertwined with the success of the group. It was completely evident that many (not just two!) diverse heads were better than one at finding the needed win-win solutions.

## Culture Change

Culture is the learned essence (“spirit,” “soul,” “DNA”) of the organization.

Organizational culture is the pattern of meanings and conceptions, shared among people and transmitted from person to person(s) that guides the way things are done in the organization. It is the complex, entrenched web of shared underlying assumptions, perspectives, values, beliefs, norms, traditions, and the like, in the

organization. A useful discussion about culture as a core concept can be found in Spencer-Oatey (2012). Note that organizational culture is distinct from organizational climate, the latter being the day-to-day atmosphere felt in an organization.

With much of the transmission of culture being subconscious, the specifics of an organizational culture will be fuzzy and can be difficult to articulate. Because of this elusive and deeply embedded nature, culture is often thought of as being relatively static, although it does gradually evolve over time. Culture influences behaviors and the assessments of behaviors of others within the organization, but it doesn't determine them. There can be subcultures within an organization, and individuals are members of multiple cultural groups. This further complicates the picture.

(Golbeck and Molgaard)

We both have graduate degrees in anthropology (Golbeck received a MA in anthropology before she received her MA in statistics and PhD in biostatistics; and Molgaard received a MA and PhD in anthropology before he received his MPH in epidemiology). We think in terms of cultures and culture change.

Not all aspects of cultures are positive. That gets us thinking of the need to change those aspects that are less positive, and how difficult and slow that can be because cultures are so elusive and deeply embedded.

Nevertheless, we have begun to hear colleagues talk about the need for culture change in our profession. There are many examples given: When we hear that a woman statistician breaks down into tears during her job interview because of an interaction with a man statistician who is interviewing her; or when we hear that, as a result of the *me too* movement, a man is afraid to mentor a woman—to meet with her alone or outside of the office—because she might make false allegations of sexual misconduct; or when we hear that a minority statistician makes great suggestions at a national committee meeting, but is rarely mentioned in the minutes.

Culture change in organizations is made easier when leaders—both titled leaders and thought leaders—practice inclusive leadership. Inclusive leadership involves the articulation of a positive vision for the culture of our profession: One of inclusive excellence. This would include a culture that not just accepts, but values and operates on DEI; facilitates equal opportunity; and mitigates implicit biases. This would include a culture that is free of stereotyping, sexual harassment, bullying, and the like. Borrowing from the anthropological concept of “limited good” where people in a group believe that if one person benefits then another person loses (i.e., there is only so much good to go around) (Foster, 1965), an ideal culture would include an image of “*limitless* good” where there is enough professional success to go around for everyone.

(Golbeck)

Many years ago, I came across a diagram for making change happen. I still remember it because it looked like a tangled-up mess. It had many states, connections between states, and feedback loops. The diagram emphasized that change can be very hard.

A few years ago, the Caucus for Women in Statistics proposed that the COPSS Florence Nightingale David Award be upgraded to a named lecture so that there could be a regular prominent lecture given by a woman at the JSM (the David award is only given to women). The Caucus reportedly worked very hard to try to make this happen, but there was a pocket of resistance as the proposal went through the COPSS committees. The initiative did not move forward.

A few years later, then-incoming COPSS Chair Bhramar Mukherjee opened the door to having a COPSS Elizabeth L. Scott Award and Lecture (the Scott award is given to both men and women), and a COPSS Florence Nightingale David Award and Lecture. I wrote a proposal to take through the door. My proposal incorporated a new strategy. This involved having lectures named after prominent, outstanding women statisticians (rather than having a lecture earmarked for a woman to give), and I collaborated with the Caucus for Women in Statistics to focus on partnerships. These partnerships included especially the leadership of COPSS, but also importantly the ASA LGBT Concerns Committee, ASA Committee on Women, SSC Committee on Women, ISI Committee on Women, and IBS/ENAR/WNAR.

I used my experience, as the system vice president at finding win-win solutions, to write the new proposal, with these many partners, that focused on the amazing statisticians after whom the lectures would be named. This time the proposal was successful. The first Florence Nightingale David Lecture was given on July 30, 2019, at the Joint Statistical Meetings in Denver; and the first Elizabeth L. Scott Lecture was given the next year.

Change is not easy, and it is important to persevere. Sometimes you have to wait until the time is right, and then change your strategy. Know what results you want, and work to get those results incrementally.

## Professional Associations

What are the major statistics professional associations doing in the area of DEI? We searched the web sites to find out. We found evidence of DEI in their missions, values statements, resolutions on equal opportunities, strategic plan themes, and lists of committees. Here are some things that were easy to locate:

- The American Statistical Association (ASA) has a strategic plan with a theme of “Enhancing the Diversity and Breadth of our Association,” which states, among other things: “In all strategies, have as an overall aim of increasing the demographic diversity of the association and the profession.” See <https://www.amstat.org/ASA/About/Strategic-Plan.aspx?hkey=ad0a3b92-31fe-4d49-b0b2-77711ae3f994>. In 2020, ASA President Wendy Martinez had as one of her presidential initiatives, LGBTQ+ inclusion in the statistics and data science profession. Details are given in the *AmStat* News (Martinez, 2020). The ASA has active committees on LGBT concerns, minorities, sexual harassment and assault, and women.
- The International Statistical Institute (ISI) has a committee on women (<https://cw-isi.org/>). The ISI has a policy on community principles and conduct which states: “As an international organisation, ISI is committed to acknowledging and taking account of all and any sensitivities across the diversity of individuals, countries and regions . . . ISI is committed to providing a professional environment free from discrimination on the basis of sex, race, colour, religion, national origin, disability, age, sexual orientation, gender identity, and politics.” See <https://www.isi-web.org/index.php/about-isi/policies/community-conduct>.
- The Committee of Presidents of Statistical Societies (COPSS) administers the Elizabeth L. Scott Award and Lecture. The award is given to “an individual who exemplifies the contributions of Elizabeth L. Scott’s lifelong efforts to further the

careers of women in academia...and [who] helped foster opportunities in statistics for women.” COPSS also administers the Florence N. David Award and Lecture. The award is given to “a female statistician who serves as a role model to other women by her contributions to the profession . . .” See <https://community.amstat.org/copss/home>.

- The Institute of Mathematical Statistics has a resolution on equal opportunities: “The IMS is an equal opportunity organization, which seeks to ensure that all of its members participate in all of its activities to the fullest extent that is appropriate, regardless of age, sex, race or ethnicity, subject matter specialty, or any other characteristic. These opportunities for participation include, but are not restricted to membership of its standing committees, its program committees for sponsored and co-sponsored meetings, and its honors and awards, including fellowships and special lectureships.” This statement is followed by a more detailed statement on “Ensuring fairness and diversity: Guidelines for IMS Awards Committees”. See <https://imstat.org/2018/06/27/ims-adopts-fairness-and-diversity-guidelines/>.
- The Statistical Society of Canada (SSC) has a bilingualism policy with a commitment “to supporting Canadian linguistic duality in the promotion of the advancement, discovery, learning and application of the statistical sciences.” ([https://ssc.ca/sites/default/files/imce/pdf/ssc\\_bilingualism\\_policy\\_2018-09-27\\_eng.pdf](https://ssc.ca/sites/default/files/imce/pdf/ssc_bilingualism_policy_2018-09-27_eng.pdf)). It has committees on bilingualism and women.
- The International Chinese Statistical Association (ICSA) in their Overview states that its “objectives are pursued without regard to race, creed, color, sex or nationality.” (<https://www.icsa.org/about/overview/>).
- The Korean International Statistical Society (KISS) likewise in their Constitution states that its “objectives are pursued without regard to race, creed, color, sex or nationality.” (<https://statkiss.org/constitution/>).
- The Royal Statistical Society (RSS) 2020 Activity Plan states that: “The Society’s Diversity & Inclusion Working Group will continue its work programme by monitoring the implementation of the Society’s high-level diversity and inclusion policy; ensuring RSS staff, volunteers, members and the wider statistical community are aware of the policy and are actively embedding it within their work; and reviewing the analysis of member data on diversity and inclusion.” It also states that: “The *Significance* editorial board will continue its efforts to better reflect the geographic and demographic diversity of the RSS membership through targeted appointment of new board members.” (<https://rss.org.uk/RSS/media/File-library/About/2019/ACTIVITY-PLAN-2020.pdf>). In addition, the RSS has a new special interest group on Women in Data Science and Statistics.

## Action Plan

Based on the principles outlined in this chapter, we suggest that STEMM employment units and professional associations should begin or continue to do the following:



1. Develop and execute a process to identify, define, and prioritize populations they deem of particular interest and importance to achieving their goals and objectives. Populations can be different for different categories of employees or members.
2. Articulate goals for increasing the recruitment, retention, and success of these priority populations.
3. List actionable strategies for advancing these goals.
4. List actionable strategies to advance a culturally competent environment.
5. Infuse DEI into the unit's and association's mission, values, resolutions, strategic plan themes, committees, and awards.
6. Create safe spaces for the difficult discussions that will promote reform toward inclusive excellence.

Our vision for the profession of statistics and data science is that it will be a leader among the STEM fields in DEI. These actions should help move us in the direction of inclusive excellence.

## References

- Bourke, J., & Espedido, A. (2019, March 29). Why inclusive leaders are good for organizations, and how to become one. *Harvard Business Review*. Retrieved 4/3/2019, from <https://hbr.org/2019/03/why-inclusive-leaders-are-good-for-organizations-and-how-to-become-one>.
- Foster, G. M. (1965). Peasant society and the image of limited good. *American Anthropologist New Series*, 67(2), 293–315.
- Golbeck, A. L. (2012, July 1). Where are the women in the JSM Registration Guide? *Amstat News*. Retrieved 4/25/2019, from <https://magazine.amstat.org/blog/2012/07/01/statviewguide/>.
- Golbeck, A. L. (2017). *Equivalence: Elizabeth L. Scott at Berkeley* (608p). Boca Raton, FL: Chapman and Hall/CRC Press. ISBN 978-1-4822-4944-6.
- Golbeck, A. L., Ash, A., Gray, M., Gumpertz, M., Jewell, N. P., Kettenring, J. R., et al. (2016). A conversation about implicit bias. *Statistical Journal of the International Association of Official Statistics*, 32, 739–755.
- Hampton, C. (2020). Diversity statements: Political test or civic duty? *The Enterprise*. Retrieved 6/8/2020, from <https://www.davisenterprise.com/local-news/ucd/diversity-statements-political-test-or-civic-duty/>.
- Krikland, J. (2018, December 3). A conversation with Ghost Light: The band we've all been waiting for. *Live & Listen*. Retrieved 12/4/2018, from <https://www.liveandlisten.com/blogs/news/a-conversation-with-ghost-light-the-band-weve-all-been-waiting-for?fbclid=IwAR2DkP24gA4KF4NvfB2F-cjpCGqBNR3SUEcHAisxsMzbzi9kxIOkdDppuSU>.
- Martinez, W. (2020, February 1). ASA initiatives 2020. *AmStat News*. Retrieved 6/8/2020, from <https://magazine.amstat.org/blog/2020/02/01/asa-initiatives-2020/>.
- McGirt, E. (2019, March 4). Chief diversity officers are set up to fail. *Fortune*. Retrieved 6/5/2020, from <https://fortune.com/2019/03/04/chief-diversity-officers-are-set-up-to-fail/>.
- Spencer-Oatey, H. (2012). What is culture? A compilation of quotations. *Global PAD Core Concepts*. Retrieved 4/24/2019, from GlobalPAD Open House <http://www.warwick.ac.uk/globalpadintercultural>.

# Power and Privilege: Reshaping the Opportunity Structure for Equitable Leadership in Statistics and Data Science



Emma Benn

If my cup won't hold but a pint, and yours holds a quart,  
wouldn't you be mean not to let me have my little half measure  
full?—Sojourner Truth, *Ain't I a Woman*, 1851 (McKissack,  
1992)

**Abstract** Innovation in statistics and data science requires the equitable elevation of diverse perspectives. In this chapter, I explore the mechanisms by which the tightly woven interplay between power and privilege serves as an impediment to and catalyst for progressively reshaping the opportunity structure for leadership in our field.

## Introduction

When Dr. Amanda Golbeck first approached me to contribute my thoughts around power and privilege to this book, I was quite hesitant for a number of reasons. First, I had never written a book chapter and while I have a wife, a novelist, who can churn out 20 chapters per day, or at least it seems that way, the proposition still felt a bit daunting to me. Second, while most of my service activities have been devoted to increasing diversity and inclusion in the field of (bio)statistics and data science, I questioned whether I had been in the game long enough to have sufficient insight to share with others. I could think of many prominent statisticians who would be better suited for this important discourse, but Dr. Golbeck, who I had first met when we participated on an *Implicit Bias in the Profession of Statistics* panel at the 2017 Joint Statistical Meetings (JSM), thought otherwise. She effectively persuaded me to put my self-doubt aside, rise to the challenge, and lend my perspective to this necessary conversation.

---

E. Benn (✉)

Icahn School of Medicine at Mt. Sinai, Brooklyn, NY, USA

e-mail: [emma.benn@mountsinai.org](mailto:emma.benn@mountsinai.org)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_2](https://doi.org/10.1007/978-3-030-60060-0_2)

## Defining Power and Privilege: Starting with #MeToo

So what would be the best way to initiate a conversation about power and privilege in statistics? Perhaps the starting point lies within the larger society and the current cultural shifts we have all been observing in real-time as a direct result of the “me too” Movement™. This grassroots movement, also referred to all over social media as the #MeToo movement, has been particularly instrumental in empowering survivors of sexual violence as well as directly confronting and holding accountable the sociostructural and sociopolitical systems at the global level that directly and/or indirectly promote sexual violence (Me too Movement, <https://metoomvmt.org/about/#history>). In a recent TEDWomen 2018 address (Me Too is a movement, not a moment, [https://www.ted.com/talks/tarana\\_burke\\_me\\_too\\_is\\_a\\_movement\\_not\\_a\\_moment?language=en](https://www.ted.com/talks/tarana_burke_me_too_is_a_movement_not_a_moment?language=en)), Ms. Tarana J. Burke, civil rights activist and founder of the “me too” Movement™, made a particularly informative statement about the relationship between power and privilege in our society by suggesting that “. . . anybody in a position of power comes with privilege and it renders those without power more vulnerable.” She further elaborated that “power and privilege doesn’t always have to destroy and take, it can be used to serve and build.” Ms. Burke’s eloquently articulated interlinking of power, privilege, and vulnerability served as a much-needed catalyst for me in that she provided a contemporary conceptual framework from which to draw for this important discourse.

Yet, before I can delve deeper, I find it necessary to make sure that I am working with standard definitions of each of these constructs so that it is easier to discuss their interplay. According to Merriam-Webster (power, <https://www.merriam-webster.com>; privilege, <https://www.merriam-webster.com>), *power* refers to having the “ability to act or produce an effect” or to having “possession of control, authority, or influence over others,” whereas *privilege* is defined as “a right or immunity granted as a peculiar benefit, advantage, or favor.” To be *vulnerable* (vulnerable, <https://www.merriam-webster.com>) would imply that an individual is “capable of being physically or emotionally abused” or, more generally, “open to attack or damage.” Thus, my interpretation of Ms. Burke’s first statement is that there are endowed benefits for individuals who are granted control or authority over others and this can leave those under their control at risk for harm. For example, I can remember being told as a graduate student by a professor that I had been awarded a fellowship that was linked to both my educational endeavors and my underrepresented status as a racial/ethnic minority. I did not know I had been nominated for anything, so this of course was an exciting surprise. Yet, the professor went further to request that I give my fellowship away to support another student in my program who while we were similarly pursuing a graduate degree, the student was not underrepresented. I was devastated. This professor, who I looked up to and who I thought had my best interest in mind, attempted to exploit my underrepresented status to benefit someone else. It was, as my godmother Nancy Kirby would say, “a soul wound.” Eventually, when I finally gathered enough courage, I spoke to someone in the administration who I thought might be able

to advocate for me and fortunately the situation was resolved. Yet, I must say that for quite a time thereafter I feared that there might be repercussions for speaking up. While that was the first time in my career that I worried about advocating for myself, which entailed pushing back against what I felt was a misuse of power or inappropriate treatment by a superior, it certainly was not the last time.

## Shining a Light on the “Vulnerable”

The harm or “damage” that vulnerable members of our community may experience as an intentional or unintentional consequence of the power and privilege exerted by another statistician or data scientist may come in many forms. In my case, something that I rightfully deserved could have been taken away from me. Speaking out, however, is not always a feasible option for some statisticians and data scientists. For example, I have known some individuals who, due to the fact that their visa status is directly linked to their employer, cannot speak out when they are mistreated. They also cannot easily walk away from their job when they feel exploited by their supervisor or overworked. Rarely do our discussions around diversity and inclusion tap into the challenges that these immigrants confront in our field. Perhaps this stems from the fact that we typically associate vulnerability with having less representation. However, nonresident aliens—a term the National Center for Education Statistics Integrated Postsecondary Education Data System (Definitions for new race and ethnicity categories, <https://nces.ed.gov/ipeds/report-your-data/race-ethnicity-definitions>) uses to refer to “a person who is not a citizen or national of the United States and who is in this country on a visa or temporary basis and does not have the right to remain indefinitely”—represent a similar if not greater proportion of those getting graduate degrees in our field, at least since 2011, as compared to US citizens and permanent residents (Statistics and biostatistics degree data, <https://www.amstat.org/asa/education/Statistics-and-Biostatistics-Degree-Data.aspx?hkey=0a32a96f-2f47-4d67-b91e-0b329f93eece>; Highlights from 2017 Degree release: Bachelor’s numbers close in on Master’s, <https://magazine.amstat.org/blog/2018/08/01/2017-degree-report/>). Therefore, we must make additional efforts to ensure that the needs of this vulnerable subgroup of immigrants are not overlooked.

Yet, before I move on, I think it is necessary to pause and reflect on this term, nonresident alien, which definitely does not sit well with me and I am certain does not sit well with the immigrants who are assigned this label with such negative connotation. Our language used to categorize different subgroups in our statistics and data science community, unfortunately, has the potential to strip individuals of their dignity. While referring to a specific group of immigrants in our field as nonresident aliens may be one major example of this dilemma, another example could be the damage that may be caused, even if unintentional, when we address someone by something other than their preferred pronouns or when we assume heteronormativity. Thornton, Green, and Benn (2019) posit that statisticians and

data scientists must acknowledge their latent assumptions about gender conformity and heteronormativity if we are to proactively create a more inclusive culture. Some ASA conferences have also started to provide individuals with the opportunity to place their preferred pronouns on their registration badges, but even outside of those spaces, those statisticians and data scientists in positions of power and privilege must find a way to use language in a way that is inviting and inclusive, rather than further marginalizing already vulnerable groups.

Students are also particularly vulnerable due to the fact that they are highly dependent on their professors and mentors to successfully meet the expectations of their educational programs as well as to jumpstart their professional careers. Thus, when a professor or mentor “harms” a student, this can result in serious repercussions for the student that may also negatively impact them as professionals. Harm, in this case, can come in many forms. Recently, statisticians, women in particular, have used their personal blogs (Lum, 2017; McClure, 2017) to go public about past experiences of sexual harassment and assault as students by professors or other prominent statisticians within the university setting as well as at statistics conferences. I should not have to explain why sexual harassment and assault is a clear abuse of power and privilege, especially when the perpetrator is not held accountable, and why this could be traumatic and likely damaging over the long term for a student, or anyone regardless of their educational or professional status. By serving with a diverse group of statisticians on the ASA Task Force on Sexual Harassment and Assault (<https://ww2.amstat.org/committees/commdetails.cfm?txtComm=ABTBOD05>; Final report of the Task Force 22jan2019, <https://www.amstat.org/asa/files/pdfs/Task%20Force%20on%20Sexual%20Harassment%20and%20Assault-FinalReport.pdf>), under the leadership of Dr. Leslie McClure, we proactively worked over the course of about 1 year to: (1) assess the magnitude of sexual harassment and assault in the ASA community, (2) revise the ASA Activities Conduct Policy, and (3) make evidence-based, policy-level recommendations for the confidential reporting of incidences of sexual harassment and assault as well as for a comprehensive review and unbiased adjudication of complaints of sexual misconduct. The work of the Task Force was instrumental in moving the statistical community forward, opening up important discourse around sexual misconduct in our field, as well as identifying proactive, progressive steps our community can take with regard to creating a safer, more inclusive, and equitable culture, especially for the most vulnerable, including students, women regardless of professional rank, and other groups.

However, there are other types of “harm” students may experience that, at times, may go unnoticed. This can take the form of exploitation when students are not credited for their work or pushed beyond their limits. In 2018, the Guardian published a piece in their Academics Anonymous series entitled *Academia is built on exploitation. We must break this vicious circle* (<https://www.theguardian.com/higher-education-network/2018/may/18/academia-exploitation-university-mental-health-professors-plagiarism>) in which the anonymous author posited that even well-intentioned professors can exploit their graduate students due to the overwhelming expectations that can come with the job. The author explained:

Even a well-meaning academic has to juggle many responsibilities. For example, a research professor must teach hundreds of undergraduates, supervise a team of PhD researchers, manage research grants and collaborations and edit publications and dissertations. Very few professors are able to accomplish all this without the overwhelming burden affecting their character and judgement.

Unfortunately, the ones most likely to be on the receiving end of this are the PhD students, postdoctoral researchers and non-academic staff, who are often on short employment contracts. These people are in very tenuous positions and have little if any recourse.

The author further scrutinized the academic system that at times both normalizes and ignores the negative behaviors of professors as it relates to the intentional or unintentional exploitation of students. While this is a global problem and thus not localized to statistics, it still speaks to the power and privilege that professors have over students and the fact that this problem is systematically reinforced by unrealistic institutional and/or self-imposed expectations around productivity and promotion. The unfair and inequitably distributed expectations are exacerbated for faculty of color due to their “token” status and female faculty for whom the number of service-related obligations and required time commitment to these tasks often surpass that which is expected of our White and/or male colleagues. Yet, we are still expected to meet or exceed the productivity of our less tasked counterparts (Edwards & Ross, 2018; Hanasono et al., 2019; Settles, Buchanan, & Dotson, 2019).

In other circumstances, professors or mentors could unfairly halt a student’s progress through their program or to the next phase as a professional due to reasons that are completely unrelated to the student’s performance or demonstrated understanding of statistics or data science, but rather due to a personal conflict or the student’s refusal to acquiesce to some exorbitant request by a professor or mentor. I can think of several statisticians that have had a professor, mentor, or supervisor unfairly attempt to prevent their progress forward as a student or professional, and while most would not openly share their experiences in public, their silence should not be interpreted as the “harm” being forgotten.

## **Power and Privilege as a Catalyst for Transformation**

Yet, while it is important to call attention to any misuse of power and privilege in our field and in society more broadly, Ms. Burke also provides us with an optimistic outlook on the transformative capacity that those with power and privilege possess. Thus, statisticians with power can use their privilege to strategically restructure our field in a more altruistic and equitable manner such that particular subgroups with less power and privilege, and most likely more vulnerable, are more optimally positioned for success and leadership.

Restructuring our field to promote equitable success and leadership can take very different forms. Sometimes it can happen informally. For example, when I think back over my approximately 7-year career as a professor, the majority of the invitations I have gotten to give a lecture, be on a panel, serve on a committee, etc.

at least in the first 5 years or so of my career have most often been due to women at more senior ranks, mostly women of color and/or LGBTQ, inviting me. I keep wondering if it was that others in the field did not see me or notice my potential, or perhaps it stems from the fact that individuals from underrepresented groups are keenly aware that we must strategically and deliberately work to position each other so that eventually others will see us. It was because of these individuals that my visibility increased. For example, it was Dr. Kim Sellers who invited me to be on the aforementioned *Implicit Bias* panel at JSM, as a follow-up to a panel she had invited me to serve on at the Women in Statistics and Data Science (WSDS) conference, and it is meeting Dr. Golbeck at that JSM panel and subsequent work I have done around increasing diversity which positioned me to lend my voice as a contributor to this book. Yet, it should not solely be the responsibility of underrepresented groups in our field to increase our own visibility and eventually gain access to opportunities that we might not have gotten otherwise.

## Intersectional Progress

I think that many of our current leaders in statistics realize that they have the power and privilege to create a more progressive opportunity structure, rather than follow the status quo. In other words, some of our leaders have begun to look to see who is not represented that should be represented before they recommend someone for a leadership position, or to give a talk, serve on a committee, serve as a journal editor, etc. There is still a lot more work to be done, however. This stems from the fact that initiatives to create a more equitable opportunity structure for leadership and success can unintentionally benefit the most privileged of the disadvantaged. I came across this phenomenon when I was introduced to the work of Kimberle Crenshaw, a professor of law and civil rights advocate, in preparation for a 2017 WSDS panel entitled *Is There Room for Intersectional Feminism in Statistics and Data Science* with Dr. Mine Dogucu and Dr. Maria Garcia. Crenshaw (1989) provides a very illustrative analogy in arguing the need for intersectionality, or intersectional feminism more specifically, when she states the following:

Imagine a basement which contains all people who are disadvantaged on the basis of race, sex, class, sexual preference, age and/or physical ability. These people are stacked . . . — with those on the bottom being disadvantaged by the full array of factors, up to the very top, where . . . all those disadvantaged by a singular factor brush up against the ceiling. A hatch is developed through which those placed immediately below can crawl . . . [it] is generally available only to those who—due to the singularity of their burden . . . are in the position to crawl through. Those who are multiply-burdened are generally left below . . .

Thus, our leaders' efforts to reshape the opportunity structure in our field will be most successful if they are intersectional. For example, efforts in our field to ensure gender equity in leadership must make sure that they not only benefit white women, but also benefit lesbian or gender nonconforming women or women with disabilities or women of color or immigrant women or others who as Crenshaw

explains are not disadvantaged by a singular factor, but rather by multiple factors. As an African-American, lesbian, woman, academic, and biostatistician, this idea of intersectionality is particularly important to me. I think, however, that as statisticians and data scientists who have intersectional identities are increasingly represented in leadership, structural-level initiatives aimed at creating a more equitable opportunity structure will undoubtedly benefit a broader, more diverse group of individuals.

## **The Power and Privilege Continuum**

However, we should not assume that only those with the most power and privilege are responsible for reshaping the opportunity structure in statistics and data science. It is important to acknowledge that power and privilege exist on a continuum rather than in some absolute fashion. In other words, each of us needs to identify our own power and privilege if we are to proactively shift the opportunity structure for leadership in our field. For example, as a first-year doctoral student, I found the fact that I was the only student of color in my graduate biostatistics program to be quite unsettling. I felt that it was not about our inability to do biostatistics, but more about the lack of exposure of underrepresented groups to the field itself. While I did not believe that I could wave some magic wand to fix this problem, I did think that collectively with other students and with the support of the administration, faculty across multiple programs, and departmental staff, we might be able to change the demographic landscape of the graduate program.

That is exactly why I cofounded the Biostatistics Epidemiology (formerly Enrichment) Summer Training (BEST) Diversity Program in 2008 at Columbia University's Mailman School of Public Health. The 8-week summer program exposes diverse (i.e., racial/ethnic minorities, economically disadvantaged, or those with disabilities) undergraduates to biostatistics and its application to cardiovascular disease-related research as well as prepare students for graduate school success. I, along with other graduate students, taught in the program, mentored the undergraduates, and assisted with many of the administrative logistics. After the first year of the program, Dr. Melissa Begg, who had been very supportive of our program and who had taken on a leadership role, was able to secure funding for BEST from the National Heart Lung and Blood Institute of the National Institutes of Health. Initially, BEST was not an easy feat. In fact, looking back, I do not know if I would advise students to take on such a big undertaking as it was difficult at times balancing the rigorous expectations of my doctoral program with ensuring that BEST ran smoothly. Yet, I was extremely passionate about BEST and when you believe in something so much, I guess you find a way to make everything work. The program has been extremely successful and has lasted for over a decade. By 2017, BEST had trained approximately 110 students of which 75% of those who had graduated from college had gone on to pursue graduate degrees (Simply the best: Celebrating a decade of diversity, <https://www.mailman.columbia.edu/public-health-now/news/simply-best-celebrating-decade-diversity>).



I really could not foresee the major impact that this program would have on diversifying the field at the time that we created it; however, I think it is a good example of understanding that our voice and our efforts can be influential regardless of where we sit on the power and privilege ladder. Even if we are not fully equipped to change the opportunity structure on our own, working collectively with others who have varying levels of power and privilege has the potential to have a more expansive impact than waiting for those at the top to figure out what strategy to pursue. I am very appreciative of the support and encouragement that Dr. Begg gave me at such an early stage in my biostatistics career as well as her continued encouragement of my pursuits around diversity and inclusion to this day. I try to pay that encouragement forward, especially when I see students and early-career professionals, like Jemar Bather and Dr. Suzanne Thornton, who have passionately worked to change the demographic landscape of our field for racial/ethnic minorities and LGBTQ+ statisticians and data scientists, respectively, and who have, quite honestly, challenged midlevel and senior-level professionals to reconsider whether we are actually doing enough.

## **Final Thoughts**

In summary, I would like to offer some final thoughts that are not aimed at concluding this discussion, but are instead aimed at propelling this conversation forward. If we are truly serious about ensuring that diverse statisticians and data scientists are more equitably promoted to leadership positions within our field, then we will have to directly confront the manner by which we intentionally or unintentionally assign power and privilege to some and vulnerability to others. The burden associated with making this necessary cultural shift should not rest solely on the most vulnerable. Instead, those of us who are most comfortably situated along the power and privilege continuum should be simultaneously contributing to and leading efforts that: (1) hold those accountable who misuse their power and privilege, (2) empower the least privileged among us, and (3) proactively advocate for a progressive, intersectional, reconfiguration of the opportunity structure in our field, so that we can collectively make progress together. These efforts should not go unnoticed. Instead, they should be celebrated as it is the dynamic cultural shifts resulting from the elevation of diverse perspectives that will undoubtedly lead to methodologic innovation, rather than the replication of the contributions of a privileged minority.

## Action Points

- Reflect on each of our unique positions within the power and privilege continuum and the extent to which we can individually and collectively reshape the opportunity structure for visibility, advancement, and leadership within our field.
- Develop and implement structural-level policies and initiatives in statistics and data science that promote the empowerment of all members of our community and can counteract the systematic intentional and unintentional mechanisms by which exploitation becomes inevitable.
- Ensure that opportunities for empowerment and advancement in statistics and data science are intersectional in nature, and thus will more optimally benefit vulnerable subgroups with varying levels of privilege.

## References

- Academics Anonymous: Academia is built on exploitation. We must break this vicious circle* [Internet]. 2018 [cited 29 August 2019]. Retrieved from <https://www.theguardian.com/higher-education-network/2018/may/18/academia-exploitation-university-mental-health-professors-plagiarism>.
- ASA Task Force on Sexual Harassment and Assault* [Internet]. [cited 29 August 2019]. Retrieved from <https://ww2.amstat.org/committees/commdetails.cfm?txtComm=ABTBOD05>.
- Crenshaw, K. (1989). *Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory, and antiracist politics* (pp. 139–167). University of Chicago Legal Forum.
- Definitions for new race and ethnicity categories* [Internet]. [cited 26 August 2019]. Retrieved from <https://nces.ed.gov/ipeds/report-your-data/race-ethnicity-definitions>.
- Edwards, W. J., & Ross, H. H. (2018). What are they saying? Black faculty at predominantly white institutions of higher education. *Journal of Human Behavior in the Social Environment*, 28(2), 142–161.
- Final report of the Task Force 22jan2019* [Internet]. 2019 [cited 29 August 2019]. Retrieved from <https://www.amstat.org/asa/files/pdfs/Task%20Force%20on%20Sexual%20Harassment%20and%20Assault-FinalReport.pdf>.
- Hanasono, L. K., Broido, E. M., Yacobucci, M. M., Root, K. V., Peña, S., & O’Neil, D. A. (2019). Secret service: Revealing gender biases in the visibility and value of service. *Journal of Diversity in Higher Education*, 12(1), 85–98.
- Highlights from 2017 Degree release: Bachelor’s numbers close in on Master’s* [Internet]. 2018 [cited 26 August 2019]. Retrieved from <https://magazine.amstat.org/blog/2018/08/01/2017-degree-report/>.
- Lum K. *Medium* [Internet] 2017. [cited 29 August 2019]. Retrieved from <https://medium.com/@kristianlum/statistics-we-have-a-problem-304638dc5de5>.
- McClure L. *Stat Girl Blog* [Internet] 2017. [cited 2019]. Retrieved from <https://statgirlblog.wordpress.com/2017/04/07/sexual-assault-and-harassment-in-stem-we-can-no-longer-afford-to-be-silent/>.
- McKissack, P. (1992). *Sojourner truth : Ain’t I a woman?* New York Scholastic Paperbacks.
- Me Too is a movement, not a moment* [Video file]. Retrieved from [https://www.ted.com/talks/tarana\\_burke\\_me\\_too\\_is\\_a\\_movement\\_not\\_a\\_moment?language=en](https://www.ted.com/talks/tarana_burke_me_too_is_a_movement_not_a_moment?language=en) [Internet]. [cited 9 September 2019].
- Me too Movement. Retrieved from <https://metoomvmt.org/about/#history>.

- power*. [Internet]. 2019 [cited 26 August 2019]. Retrieved from <https://www.merriam-webster.com>.
- privilege*. [Internet]. 2019 [cited 26 August 2019]. Retrieved from <https://www.merriam-webster.com>.
- Settles, I. H., Buchanan, N. T., & Dotson, K. (2019). Scrutinized but not recognized: (In)visibility and hypervisibility experiences of faculty of color. *Journal of Vocational Behavior, 113*, 62–74.
- Simply the best: Celebrating a decade of diversity* [Internet]. 2017 [cited 29 August 2019]. Retrieved from <https://www.mailman.columbia.edu/public-health-now/news/simply-best-celebrating-decade-diversity>.
- Statistics and biostatistics degree data* [Internet]. 2019 [cited 26 August 2019]. Retrieved from <https://www.amstat.org/asa/education/Statistics-and-Biostatistics-Degree-Data.aspx?hkey=0a32a96f-2f47-4d67-b91e-0b329f93eece>.
- Thornton, S., Green, B., & Benn, E. (2019). Friends and allies: LGBT+ inclusion in statistics and data science. *Significance, 16*(3), 39–41.
- vulnerable*. [Internet]. 2019 [cited 26 August 2019]. Retrieved from <https://www.merriam-webster.com>.

# **Part II**

## **Leading Teams**

# Leading Collaboration in the Data Zone



Nancy Fagenson Potok

**Abstract** Today's data environment is rapidly evolving as are the skills we need to succeed. People who can work collaboratively are in demand. Understanding how to lead successfully on data-based work collaborations is a necessary skill. Focus on the human element in addition to the data is needed.

## Why Collaborate?

Today's data environment is rapidly evolving, and our expectations for creation and use of high-quality data are rising commensurately. Changes in the way we receive and use information affect our personal and professional lives. One result is that data users are demanding more information that is unbiased, timely, relevant, and granular. This expectation affects how we work and the skills we need to succeed. Data-driven evidence building and decision making require a diverse mix of skills to collect, curate, analyze, and disseminate high-quality data from a variety of sources. Due to the increasing complexities surrounding the interactions of technology, data science, statistical methods, and types of data sets, the demand for people who can work collaboratively with others in the new data ecosystem is also increasing. Understanding the key elements of successfully leading collaboration in this data zone is a necessary skill.

## Technological Change Is Rapidly Accelerating

As a young child, I had a set weekday morning routine. My dad woke up my brother and me, we did a set of exercises from the newly published book by the Royal

---

N. F. Potok (✉)  
Office of Management and Budget, Beltsville, MD, USA  
e-mail: [npotok@gwu.edu](mailto:npotok@gwu.edu)

© This is a U.S. government work and not under copyright protection in the U.S.;  
foreign copyright protection may apply 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,  
[https://doi.org/10.1007/978-3-030-60060-0\\_3](https://doi.org/10.1007/978-3-030-60060-0_3)

Canadian Air Force, and then we sat together at the breakfast table eating slow-cooked hot cereal and cocoa. My dad would glance at his watch often to make sure we were on time. Sometimes my brother and I had a little extra time to watch morning children's shows on our black-and-white TV, and I could tell what time it was by the regularly scheduled programming. There were no constant news updates throughout the day unless there was an emergency such as a tornado warning, school closing, or major disaster. The family sat together in the living room in the evenings watching the news on three available TV channels. I enjoyed browsing through our set of hardcover encyclopedias. To update them, you had to buy entirely new hardcover books that came out once a year. During the summer, my neighborhood friends and I played outside all day and knew it was time to come home when the streetlights came on.

By the time I was in high school, I used a digital clock radio to wake up. I drove to school while listening to my favorite songs on 8-track cassette tapes, although I still bought a lot of vinyl record albums for my turntable stereo. I wore an analog watch to tell time. My parents got me my own landline phone number, because I talked on the phone constantly with my friends, and I enjoyed being able to talk in my bedroom. My friends and I made our plans in advance, because we knew we would not be able to reach each other by phone once we left the house. Fortunately, my friends physically lived within about a 2-square-mile radius of each other, so it wasn't that hard to find people.

When I started college, I registered for my classes by standing in long lines at various folding tables set up in a large gymnasium, handing in computer punch cards to register for the classes I wanted. Our grades came in the mail at the end of the semester, as did all information about housing, food plans, and other school-related activities. I had a landline phone in my dormitory room, and all friends seemed within easy reach on campus. I didn't talk to my parents too often, because long distance phone calls were expensive.

My first job after college was technical writing for the government. I learned both how to program a mainframe computer and to solder transistors onto circuit boards. I got a cassette tape player and recorder, started making mix tapes, and stopped buying vinyl record albums. I bought a digital watch and subscribed to cable TV.

After graduate school, I continued working in public service. The next 7 years saw major office technology advances. My agency automated our budget and accounting system. We each got massive desktop computers that used a Disk Operating System (DOS) and cathode ray tube (CRT) monitor, and we were connected to a local area network, so we could send email to coworkers. We saved documents on floppy disks. Our phones started to have interesting features such as built in voicemail, conference speakers, and memory dial. The secretaries became unhappy and anxious, because they thought that automation would eliminate their jobs, which consisted of typing, answering phones, and making carbon copies.

By the time my own children were in elementary school, we had a home computer and were connected to the internet. Their school had set up a computer lab. We had cable TV with a Digital Video Recorder (DVR). The children's lives were being recorded on a camcorder and could be played back instantly on our Video Cassette Recorder (VCR). We switched to cordless landline phones and got our first

plug-in car phone, along with a Digital Versatile Disc (DVD) player. I got my first Personal Digital Assistant (PDA).

When my children were in high school, they each had their own cell phones that took pictures and video that they could post online. We had wi-fi in the house, Bluetooth in the car, and all our remaining cameras were digital. I got a laptop. My kids and I stopped talking on the phone in favor of texting but I still talked to my parents on a landline. I stopped front-porch newspaper delivery and got all my news instantly on line. I joined social media, and my daughter was an instant pro on other constantly emerging social media I could not keep up with. We started talking about apps in everyday conversation.

When my kids went off to college, they each had laptops and smartphones. I had a tablet. All of their communications with their school were online. All their communications with me were by text, with an actual phone conversation becoming a rare event. They had never seen a punch card. They had never used a paper roadmap. I began conducting most of my transactions online and was delighted with free 2-day delivery, crowd-sourced restaurant and travel reviews, and streaming entertainment. I was not so delighted with being connected with work wherever I went, 24/7.

Now my geographically dispersed children and I stay in touch with video chats, instant photos, and texting. We take our smartphones, apps, and online life for granted, but realize there are tradeoffs. My friends are all over the world, but I never have trouble finding them. I video chat with my young grandchildren, but their screen time is restricted by their parents, who have read research about screen time affecting brain development in children. We expect our news and entertainment instantly but are often disenchanted with social media's role in the spread of news. There is not a single question that comes up during dinner conversation that we can't instantly answer with our smart phones, whether it be right or wrong information. We never get lost while driving, but we are irritated when we are not routed to where there is the least traffic. We expect that we soon will have self-driving cars, precision medical treatment, and self-regulated and maintained homes, but we fret about our lost privacy as a result of all this convenience. We fret about the future of work in a world that is continually more automated, but we feel the need to apologize about not answering work phones and email while on vacation. We know that many of the data and algorithm-driven gadgets and services we rely on today will soon be obsolete.

This accelerating pace of new technology adoption and availability of information over the past 50 years is not out of the ordinary for many people. But it has profoundly changed workplace expectations and the skills needed to succeed. The stereotype of an expert in statistics sitting alone in front of the computer to work with data and create statistics is fast fading into the past. Rather, today's workplace is becoming more collaborative, incorporating new sources of data into statistics, requiring new methods of measuring quality and error, and broadening the pool of practitioners and stakeholders around the data ecosystem.

## Challenges and Opportunities

Public agencies that are in the business of providing data have seen significant changes in the needs of their core constituency, data users. One example of changing expectations in the statistical world is in the area of economic indicators. Data users are no longer satisfied with receiving monthly information at a national level on retail sales or housing construction starts. They want daily updates on retail sales in Chicago, Los Angeles, Dallas, and other markets. And they want the data to be easily accessible and understandable. States want to link their employment and education data across agency silos to understand better job and earnings outcomes within their states. And they want to be able to see the outcomes for residents who may go to school or reside in one state but work in a neighboring state. In all fields, researchers want easier access to research and data sets related to their interests, and more information about the quality and provenance of data they are using in their own research.

At the same time, people want to protect their privacy, and various polls and surveys have shown that the public has decreasing trust in government, including its ability to safeguard their personal data (Childs, 2016; Mitchell, Childs, & Earp, 2013). These attitudes are demonstrated in the longer-term trend of falling response rates to surveys conducted by the U.S. federal government (Meyer, Mok, & Sullivan, 2015; Tourangeau & Plewes, 2013). Some research has shown that people who do respond to surveys are not always providing accurate answers on those surveys, particularly in sensitive areas of inquiry, such as income or citizenship (Meyer & Mittag, 2015). When people or businesses do provide data to the government, whether that is through surveys or submitting forms required to participate in various benefit programs, they expect the government to protect their privacy as well. Although laws such as the *Confidential Information and Statistical Efficiency Act (CIPSEA)* (CIPSEA, n.d.) and the *Privacy Act (1974)* require that data be safeguarded and provide for fines or even jail time if protected data are knowingly revealed for unauthorized uses, people are mistrustful. The lower response rates on surveys have driven statistical agencies to look beyond the traditional means of data collection to other sources of data such as commercial data and administrative data from programs. For example, the Census Bureau has done research to determine whether aggregated credit card data can help estimate retail sales on a more frequent basis and at lower levels of geography than a monthly survey of retail establishments. The National Agricultural Statistics Service has looked at using satellite photos in estimating crops rather than surveying farmers. Other statistical agencies are conducting similar types of research.

Because data used to support policymaking need to be of dependably high quality, they should be objective, unbiased, timely, and relevant. Increased production of combined data sets from sources such as surveys, program evaluations, program administrative data, commercial data, and open data on the internet, combined with improvements in computing power and the ability to access much more data electronically, creates both challenges and opportunities. The challenges include



openly informing data users how the data were collected and for what purposes; measuring quality and describing to users in a standard understandable way for what purposes these new data sets are fit to be used; navigating various permissions and licenses around various data sets; understanding and respecting the rights of the original owners of the data; and balancing risk of re-identification of individual data with the benefits of use and the sensitivity of the data set (Potok, 2017). The opportunities include gaining more insights from the data at a lower cost and reducing burden for survey respondents. These insights can change people's lives in areas such as health care, housing, food security, environmental protection, and educational choices.

Of course, not all data are being collected and used for statistical purposes. Title II of the *Foundations for Evidence-Based Policy Making Act (PL-115-435)*, The OPEN Government Data Act, requires that US federal agencies appoint Chief Data Officers, maintain inventories of all data, make all non-sensitive data available to the public in machine-readable format, and that the government create a catalog of available data.

## ***Collaboration and Organizational Culture***

The US government's Federal Data Strategy (<https://strategy.data.gov>) calls for agencies to set up data governance in order to help agencies leverage their data as a strategic asset. Together, the Evidence Act, and the data strategy, along with guidance that has been issued to agencies from the U.S. Office of Management and Budget and presidential Executive Orders (Office of Management and Budget, 2014; Office of Management and Budget, 2016), provide a strong mandate for greater collaboration on both open data and sharing sensitive data for statistical purposes. At the federal level, the emphasis on collaboration aims to reduce barriers to sharing data across agency program silos and between different agencies. The focus on governance is intended to bring multidisciplinary expertise together to formulate and address operational and evaluative questions that agencies have found difficult to tackle in the past due to lack of available data. These approaches also work in the private sector, particularly in very large organizations.

The rapid changes taking place around the collection, management, and dissemination of data in the private and public sectors, which affect not only our personal lives, but how we interact and do our jobs in the workplace, require new skills and behavioral changes. Successful interactions require cooperating and collaborating with others in a turbulent, fast-changing environment. Many organizations are structured as hierarchies that are not conducive to collaboration, and the incentives are not geared toward fostering cooperation across organizational lines. Tackling these barriers requires substantial culture change at all levels of the organization.

Because collaboration is an inherently inclusive and diverse activity, in a forward-looking data-centric environment, many entities may be involved in an organization's data ecosystem. Government collects and disseminates much valu-

able data. However, the private sector is a rapidly growing source of big data sets created through delivering products and services. Academia provides research on statistics, data science, computer science, privacy protection, and social science-based outcome measurement to both the private and public sectors. Foundations and nonprofits have been key players in providing funding and conducting their own social science research to advance evidence-based policy. Navigating this network requires skill and experience.

In addition, players within one's own organization, such as chief data officers, chief information officers, privacy officials, chief statisticians and economists, subject matter experts, data owners, program managers, and others, all have a stake in governing and leveraging data. Harnessing the collective strengths of each stakeholder can be challenging, but when accomplished successfully, yields valuable results.

One example of successful collaboration within a data ecosystem can be found at the National Oceanic and Atmospheric Administration (NOAA). NOAA is a data-focused science agency, with over 98,000 data sets on climate, weather, fisheries, and other areas within its purview. While NOAA isn't a statistical agency, its data are used internationally for statistical and other research by climatologists, meteorologists, oceanographers, and other environmental scientists as well as private sector companies that commercialize NOAA data for easy consumption by the public. NOAA's Chief Data Officer works closely with the agency's own scientists and technologists to make sure that NOAA is meeting the research data needs of NOAA data users. NOAA also maintains a publicly accessible reference library of its publications and looks for feedback on how to improve its data from its users. The Chief Data Officer fosters a collaborative environment in order to standardize metadata, improve access, and perform other data management functions, while scientists use feedback to improve the quality and usefulness of their data output. The outside researchers build knowledge to inform public policy, and the private companies provide value to the public while creating jobs and contributing to economic growth.

## **Elements of Success**

However, leading collaboration successfully requires a balance of many factors. Often, culture change is needed within an organization that is not accustomed to working horizontally or outside of vertical silos. Risk taking may not be rewarded nor innovation fostered and appreciated. Former leaders may have established a culture of competition rather than cooperation.

Strategic leadership is needed to lead culture change successfully. Operational leaders expect people in their organizations to be able to adapt quickly to change. But people resist, accept, or embrace change based on their own understanding of how that change will affect them personally. The role of strategic leaders who want to foster collaboration is to create an environment where people can embrace,

rather than reject change and make positive contributions to the success of the organization.

The inability of an organization to be successful strategically is often a result of three factors. The first is a lack of focus. This happens when organizations can't prioritize their mission-related activities, avoid the hard decisions, and try to do too much for too many. The second factor is misalignment. That is, the resources of the organization are misaligned with its strategy. People, money, and structure are not pointed toward achieving the stated goals. The third factor is shortsightedness, which occurs when leaders focus solely on short-term success at the expense of long-term viability.

There exists a large body of literature and research on strategic leadership, how to successfully accomplish culture change in an organization, and fostering a culture of collaboration and innovation. For example, Bennis & Goldsmith identify successful leaders as ethical problem solvers that work in collaborative mode to "... create stimulating, synergistic connections, support honest interactions, build trusting relationships, and encourage self-management across organizational lines" (Bennis & Goldsmith, 2010). Other characteristics they identify include flexibility, tenacity, authenticity, the ability to see connections and relationships between both people and events, working with others to discover solutions, linking people through dialogue, and a forward-looking perspective.

Goldstein (2016) highlights Seven Characteristics of Innovative Public Service Organizations put forth by Borins, including (1) supporting innovation from the top; (2) rewarding individuals who push change; (3) dedicating resources to innovation; (4) harboring a workforce with diverse perspectives; (5) learning from the outside; (6) making innovation everyone's responsibility; and (7) exhibiting an inclination to experiment and evaluate (Borins, 2006).

However, successful change is people-dependent. Addressing the human side of change means managing transitions from the old way of doing things to the new. For individuals, these transitions are internalized as they step away from the known and stable into a period of ambiguity and possible frustration. However, as change begins to be implemented, people begin to take action and feel more like they are on solid ground. Making the transition successfully and changing one's behavior requires that leadership create a trustworthy process during the time of instability that includes transparency, involvement, and truth-telling.

But how does one know where to start? The large body of literature and advice is overwhelming, even for a data expert. The many sources of guidance can be daunting for the practitioner to sort through and then synthesize key lessons that organizational leaders looking to build a collaborative environment can apply in their own data ecosystems. The three key steps below are a more simplified approach to being successful in a collaborative environment. Start by creating a roadmap that points in the direction you want to go.

## Three Keys Steps to Creating a Roadmap for Successful Collaborations Around Data

### *Step 1. Problem Solving*

To engage willing collaborators, leaders must motivate people. According to Pink, after their basic needs are met, people at work are motivated by intrinsic factors such as interesting, challenging, and absorbing projects rather than by external factors such as money (Pink, 2009). They want to make meaningful contributions to their organizations and the greater community, feel empowered, and work in an environment where power is based on collaboration and reason. Coalescing around solving high-priority problems can be a great motivator.

*Identify high-priority areas.* Once an organization's vision and strategic goals are established, a collaborative leader will enable people to identify high-priority areas that need attention in order to achieve the goals. Five questions that can help identify these high-priority focus areas are to understand: (1) What is already working? (2) What caused this success? (3) What is our objective? (4) What are the benefits of accomplishing this objective? and (5) What can we do more, better, or differently to move closer to our objective?

*Formulate questions around big problems you want to solve.* Organizations will differ considerably in formulating these questions. For many organizations, program outcomes, operational improvements, and compliance questions are likely to take precedence. For example, you may want to know whether particular programs are achieving their intended outcomes, such as whether food security programs are effectively being utilized by their target populations. You may want to know whether lifetime earnings for high-school graduates are higher if they earn certain technical certifications while in high school. You may want to understand better the patterns of veterans' usage of health care, so services can be targeted more effectively. Or perhaps your primary goal is to increase your operational efficiency to save money—you may want to use algorithms and machine learning to set up better preventive maintenance schedules for ships, planes, or heavy equipment with expensive parts. Or you are a compliance agency, and you would like to develop better predictive models to look for anomalies in the reporting of the entities over which you have oversight. These are big questions that collaborating around data can help answer, regardless of your organization's mission.

*Identify needed data.* Once you have identified these questions, you can then identify the type of data you need to answer these questions. This also is a collaborative activity, because it is increasingly likely that there are multiple data owners and subject-matter experts. You will need a team to identify both the data needed and the barriers and risks around acquiring and using those data. Strategic leadership will again be needed to find allies in the organization who are motivated to help both with the identification tasks and in overcoming the barriers. Many of the datasets may be statistical data that need to be protected.

*Scope your environment.* A part of this task is to scope the organization's environment. The external environment consists of factors outside the organization having an indirect impact on achievement of objectives, and which are not within the organization's control. These can include rules and regulations, laws governing the use of particular data sets, Executive Orders, OMB guidance memos, and congressional or Inspector General oversight.

*Identify and bring in allies.* The internal environment consists of factors having a direct impact on the organization, and over which the organization has control. In the public sector, these often include opposing interests in the governance structure and in the C suite offices, program managers who do not want their programs to face scrutiny, outside stakeholders who don't want programs to change course, budget constraints, organizational culture that resists change, and organizational policies. A motivated team could effectively identify and implement valuable and visible solutions to the internal barriers to achieving your stated goals with the right leadership.

*Seek external partners.* One important aspect of collaboration is to look outside your larger organization. For example, public sector organizations partnering with academia and the private sector can help with all aspects of problem solving from assisting with designing rigorous studies to recommending appropriate technologies and applications that already exist or can be readily developed by the data science community. Partners can also help organize and hold workshops that bring experts together around specific problem solving challenges and can energize the creation of white papers and other research to help advance knowledge and evidence building in areas that are of interest.

## ***Step 2. Governance***

Data governance is the process of setting and enforcing priorities for managing data as a strategic asset in service of an agency's (or organization's) mission, including its strategic plan and other high-level priorities (Office of Management and Budget, 2019). It is an inherently collaborative undertaking, and often where organizations can start to establish primary roles and responsibilities over shared activities. Establishing policies around management of and access to key data assets is foundational to undertaking many data-driven activities. Effective implementation of data governance supports agency strategic priorities, identifies resources to implement those priorities, coordinates and supports implementation of data management responsibilities, sets agency data policy, and brings key players together around problem solving.

*Create Guiding Principles.* It is helpful to have some guiding principles for data governance. These could include recognizing that data are strategic assets, data should be managed as shared assets to maximize business value and reduce risk, data should not be unnecessarily duplicated, data quality standards should be defined and monitored, and data shall be protected as required by law and regulation. Data

governance policies and decisions need to be clearly communicated and transparent to all participants in the data lifecycle.

*Determine Roles and Responsibilities.* Typically, data governance assigns roles and responsibilities for data management activities such as data architecture, data modeling and design, data storage and operations, data security, data integration and interoperability, documentation, reference and master data, metadata, data quality, and assuring privacy and confidentiality protections are in place. Collaboration allows participants to bring their strengths to the table. Too frequently, collaboration breaks down when people are unwilling to share responsibility and clearly define roles. One of the biggest challenges for a collaboration leader is to organize and motivate team members around solving the problem, rather than around amassing control. It is imperative that leadership of an organization makes decisions and enforces those decisions if roles and responsibilities are fuzzy and dysfunctional. If a group cannot reach consensus on its own, it is the responsibility of leadership to step in and make these determinations promptly so that governance remains viable and focused.

*Create a data governance council.* A council can take many forms in terms of membership. The important element is that people with responsibility and authority participate. The membership of a data council can be fluid. For example, there may be a small core membership, consisting of the chief data officer, the chief statistician, the chief privacy officer, the chief scientist, and the chief information officer or chief technology officer. Others, such as subject-matter experts, program managers, data scientists, and data owners, should participate when a high-priority question being answered with data is within their expertise and purview. For example, suppose your organization has determined that it is a high priority to maximize the efficiency of preventive maintenance schedules on equipment, and the data on equipment maintenance and breakdowns are captured and maintained in a program area. It is important that the program managers who understand the data, including the quality of the data, be at the table when a study of those data is being designed. They need to be part of the discussion on how those data are structured, maintained, and protected. The same holds true in organizations that collect highly sensitive data, such as protected health data or statistical microdata on individuals or businesses. Organizations need to find a balance between setting and enforcing standards on data management and the needs of the programs collecting and using the data. They should be complementary, with value and utility balanced against costs and risks. A data council can be a useful forum for fostering that type of collaboration.

*Identify the key, high-value data sets.* Many organizations are awash in data. The task of even identifying all the data that exist can be overwhelming in both the public and private sectors. One way to cut the task down to size is to identify the key, high-value data sets in your organization that should be prioritized from an evidence-building or operations research standpoint. Starting with the high-priority data helps model and build the changes in collaborative behavior, data management, and resource allocation that you want to become the norm throughout the organization. The task is focused, and data management efforts can be tested before being rolled out to the entire organization. Others throughout the organization

will want to know what tools are available, how much money and how many people need to be devoted to tasks such as creating a data inventory, creating a catalog of research and studies that have been undertaken and with what data sets, how to handle older data that may be stored in difficult to access data formats, how to assess data quality, and what type of outside expertise has been brought in to assist.

*Design and execute a pilot project.* Identifying high-priority data sets that will help address high-priority questions in an organization leads naturally to using the data to answer the questions. A pilot project can be a manageable approach to creating early wins in high-visibility areas. It is an excellent way to test out the governance processes, understand issues around acquiring data from across the organization and from other organizations, assessing data quality and whether the data are fit for the purposes that are intended in the pilot, create rigorous, scientific research and study designs, explore new data science and statistical approaches to mining the data, and demonstrate the value of collaborative work. A pilot project should be scoped so that it can be started and completed in a reasonable period of time. Both successes and failures should be well documented. The participants in the pilot should be broadly recognized and appropriately rewarded by the organization. And the resulting information gleaned from the studies should be visibly used in making important strategic decisions. When people around the organization see what can be achieved with a well-run pilot, they will start to recognize the value of collaborative actions around data.

### ***Step 3. Institutionalize Changes***

*Build on Momentum.* A single pilot project can be very effective in bringing attention to new collaborative approaches to using data as a strategic asset for an organization. But that attention needs to be sustained by leadership action. More high-priority, high-impact projects need to be supported. Stakeholders throughout the organization need to begin to engage rather than observe from a distance. Barriers identified during the pilot need to be tackled. Some barriers will be formidable, particularly around the laws and rules for sharing sensitive data. Other barriers may involve lack of resources, ongoing production demands, or resistance to change. But forward progress is needed if the gains from the pilot are to be institutionalized more generally.

*Assess and build existing staff skills.* One barrier may be that the existing staff does not have the right mix of skills to conduct the type of analyses needed to address the high-priority questions. But staff can be trained. Training programs exist that can address the questions while training staff on how to work with multiple data sets that need to be curated and linked. Bringing diverse employees with different areas of expertise together in a lab environment is an effective way to build both technical and collaboration skills. Subject-matter experts and coders can work and learn together around problem solving and contribute important information to their organizations at the same time. Some employees may benefit from professional

certification programs or graduate-degree programs. But it is important to think about what skills are needed to work collaboratively with data, assess the existing skills of employees, and establish training tracks that will build the skills that are lacking.

*Bring in new people with needed skills.* Once needed skills are identified, the organization should update its hiring practices to assure that new hires have those skills. This is a quick way of increasing the overall competency of the workforce. In some public sector agencies, it is difficult to attract those people with the right skills, due to a variety of factors such as low starting salaries, or lack of vacancies and low turnover. In those instances, many agencies turn to contractors to fill the gap in the short term.

*Modernize IT approaches.* Many organizations, particularly government agencies, have an outmoded IT infrastructure that doesn't lend itself to the kind of agile, scientific, high powered computing that is needed to access and work with data. Investments in IT infrastructure should be weighed carefully with current and future data collaboration needs in mind. More and more organizations are choosing to treat their basic IT infrastructure more like a utility that can be outsourced to companies that specialize in providing secure computing environments. Because technology is rapidly advancing, an organization must determine whether there is a positive benefit cost risk tradeoff in making substantial capital investments in owning infrastructure when secure platforms and software can be provided as a service that is kept up to date. Then leadership attention can be focused on collaborative problem solving rather than on procurement and maintenance of equipment.

*Establish and support an ongoing collaborative research program.* Data science methods are continuously improving. Testing and experimentally applying new data mining, statistical modeling, machine learning, data linkage, and other approaches can yield insights in evidence building that might otherwise take years to discover. Successful research in the data world is collaborative activity. Just as problem solving for pilot projects requires a mix of subject-matter experts, statisticians and data scientists, data managers, and program managers, so too does research. People can take controlled risks in a research environment that may lead to enormous breakthroughs. Keeping current in an era of rapid change requires a robust ongoing research program.

*Formalize the governance structure for ongoing data management and stewardship.* In order to continue to foster collaboration, the roles and responsibilities of data managers and stewards should be captured and documented. This can be in the form of a charter for the data governance council or in other documentation on standard operating procedures for an organization. The important contributions of the subject-matter experts, data scientists, statisticians, privacy experts, evaluation experts, technology officials and program managers also must be captured and documented. People need to feel they are a valued and important part of the data ecosystem in order to be motivated to participate in collaborative problem solving. Documentation that is recognized and adhered to is an important tool for gaining such cooperation.



*Build outside stakeholder support for maintaining changes.* Positive reinforcement is an effective mechanism for maintaining cultural and operational changes in an organization. The support of outside stakeholders can serve to reinforce the collaborative behaviors that produce results that data users, good government advocates, and policy experts value. Producing high-quality evidence that informs public policy should be recognized. When qualified researchers can get access to data, their research should credit the organization's ability to provide high-quality data. Too often the feedback received by organizations is negative. Positive feedback from stakeholders can be a meaningful and powerful motivator.

## The Journey

Providing leadership to create and work in a collaborative data ecosystem is a journey. The pace of change in the workplace and within the data ecosystem is rapid. But changes in an organization need to be intentional and measured and should be appropriately paced rather than rushed. A heavy focus on the human element is needed to bring people along with the change. Here are some simple guidelines to remember:

- *Start simple.* If your efforts are too complex and difficult to explain in a few sentences, you will have trouble gaining broad understanding of both what you are trying to achieve and why it is important. Articulate the problems you are trying to solve in a straightforward way that is actionable inside and outside your organization.
- *Set achievable goals.* Goals should be both long term and short term. People need to see some early successes to stay motivated.
- *Build your roadmap.* Follow the three key steps described earlier to build your roadmap. These include (1) problem solving, (2) governance, and (3) institutionalizing the change.
- *Engage first those that want to be involved.* Find the people in your organization who are comfortable with and want to be agents of change. These are not necessarily the people highest in the management chain. Organizations often have informal influencers that can either make or break change efforts. Enlist the change agents who want to collaborate and grow professionally, with a focus on addressing the big questions.
- *Identify priority areas first, then develop the processes.* People are motivated by problem solving to reach the goals. Tangible outcomes such as new products are easy to visualize. Very few people are excited about putting new processes in place for the sake of having new processes. The governance roles and responsibilities can be built into job descriptions that include needed up-to-date skills. Data governance can then be tied to business results to show the value of the new collaborative approaches.

- *Use new technologies but continue to pay close attention to data quality and scientific rigor.* Advanced technology can be a critical element in taking you to the next level of working with data, but if you start introducing bias and errors into your data outputs, technology alone will not compensate for the problems that will ensue.
- *Proactively seek outside expertise and partners.* Your organization can gain insights, new technological approaches, fresh ideas, and additional intellectual power applied to problem-solving efforts through bringing in outside expertise.
- *Most of all, provide value.* When you are providing recognized value to your organization and its stakeholders, the positive feedback provides outstanding incentives for continuing the journey for greater collaboration and successful results.

## References

- Bennis, W., & Goldsmith, J. (2010). *Learning to lead: A workbook on becoming a leader* (p. xvii). New York: Basic Books.
- Borins, S. (2006). *The challenge of innovating in government. Innovation series* (2nd ed., pp. 28–32). Washington, DC: IBM Center for the Business of Government. Retrieved from <http://www.businessofgovernment.org/sites/default/files/BorinsInnovatingInGov.pdf>.
- Childs, J. H. (2016). *Understanding trust in official statistics in the U.S. and implications for administrative record use*. Submitted to the Commission on Evidence Based Policymaking, Washington, DC.
- Confidential Information and Statistical Efficiency Act (CIPSEA), Pub. L. No. 107-347, § 501 et seq.
- Goldstein, I. (2016). *The federal management playbook* (p. 208). Washington, DC: Georgetown University Press.
- Meyer, B. D., & Mittag, N. (2015). *Using linked survey and administrative data to better measure income: implications for poverty, program effectiveness, and holes in the safety net*. National Bureau for Economic Research Working Paper 21676, Washington, DC.
- Meyer, B. D., Mok, W. K. C., & Sullivan, J. X. (2015). Household surveys in crisis. *Journal of Economic Perspectives*, 29(4), 199–226.
- Mitchell, M., Childs, J. H., & Earp, M. (2013). Monitoring and detecting shocks that influence public trust towards the federal statistical system. *Paper presented at the 68th Annual Conference of the American Association of Public Opinion Research*, Boston, MA. [http://www.aapor.org/AAPOR\\_Main/media/AnnualMeetingProceedings/2013/Session\\_H-5-2-Mitchell.pdf](http://www.aapor.org/AAPOR_Main/media/AnnualMeetingProceedings/2013/Session_H-5-2-Mitchell.pdf)
- Office of Management and Budget. (2014, February 14) *Guidance for providing and using administrative data for statistical purposes, memorandum M-14-06*. Washington, DC: Executive Office of the President; White House, E.O. 13859 on Maintaining American Leadership in Artificial Intelligence, issued February 11, 2019.
- Office of Management and Budget. (2016, November 8) *Open data policy: Managing information as an asset*, memorandum M-13-13. Washington, DC: Executive Office of the President. Retrieved from <https://project-open-data.cio.gov/policy-memo>.

- Office of Management and Budget. (2019, July 10). *Guidance memo M-19-23 Phase 1 implementation of the foundations for evidence-based policymaking act of 2018: Learning agendas, personnel, and planning guidance*. U.S. Office of Management and Budget memorandum M-19-23, Washington, DC. Retrieved from <https://www.whitehouse.gov/wp-content/uploads/2019/07/M-19-23.pdf>.
- Pink, D. (2009). *Drive: The surprising truth about what motivates us*. New York: Riverhead Books.
- Potok, N. (2017). Standards and guidelines for combined statistical data. *Annals of the American Academy of Political and Social Science*, 675(1), 36–40. Washington, DC: Sage Publications.
- Privacy Act, 5 USC § 552a et seq (1974).
- Tourangeau, R., & Plewes, T. (Eds.) (2013). *Nonresponse in social science surveys: A research agenda*. National Research Council Panel on a Research Agenda for the Future of Social Science Data Collection, Committee on National Statistics, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

# Team Science in Biostatistical Collaboration: An Opportunity to Practice Leadership, Embrace Diversity, Manage Conflict, and Share Credit



Jaya M. Satagopan and Madhu Mazumdar

**Abstract** Multidisciplinary scientific teams are crucial for addressing formidable health problems. The increasing need to design, collect, analyze, and interpret health data places biostatisticians at the center of team science. Nuanced practice of leadership, accepting diversity, conflict management, and credit sharing are crucial for effective integration of biostatisticians into team science.

## Introduction

Scientific discovery, research methods, and translating the results to benefit the public are becoming increasingly specialized. Interdependence, shared vision, joint ownership, and collective accountability between multiple researchers with diverse scientific backgrounds and skill sets are key requirements for solving scientific problems in today's biomedical research enterprise (Bennett, Gadlin, & Marchand, 2018). Therefore, team science, which harnesses the strengths of professionals trained in a myriad of fields, has emerged as a dominant strategy for producing scientific knowledge.

Team science has led to numerous breakthroughs in medicine that would not otherwise have been possible. This includes the development of human papilloma virus (HPV) vaccination against anal HPV infection (Kreimer et al., 2011), molecular characterization of multiple types of cancers through the Cancer Genome Atlas (2008, 2012, 2015), affirmation that colonoscopy significantly reduces death due

---

J. M. Satagopan (✉)

Department of Epidemiology and Biostatistics, Memorial Sloan Kettering Cancer Center, New York, NY, USA

e-mail: [satagopj@mskcc.org](mailto:satagopj@mskcc.org)

M. Mazumdar

Institute for Healthcare Delivery Science, Mount Sinai Health System, New York, NY, USA

e-mail: [madhu.mazumdar@mountsinai.org](mailto:madhu.mazumdar@mountsinai.org)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_4](https://doi.org/10.1007/978-3-030-60060-0_4)

to colon cancer (Zauber et al., 2012), and the development of immunotherapy for cancer treatment (Forde et al., 2018). Biostatisticians were an essential part of these study teams and contributed as collaborators and leaders in the design, implementation, analysis, and reporting phases of these projects. This chapter examines the central role of biostatisticians in team science for biomedical and health services research. We examine some of the critical ingredients for successful integration of biostatisticians as collaborators in team science and ways to sustain this integration to realize lasting solutions. We use our experiences as biostatisticians of oncology and orthopedics research teams as illustrative examples.

## Team Science

Scientific research is more of a team effort today than it was decades ago (Wuchty, Jones, & Uzzi, 2007). A study of authorship in medical journals revealed a growing trend toward team science, i.e., collaborations between professionals with training in diverse backgrounds to address scientific challenges (Weeks, Wallace, & Kimberly, 2004). The mantra of team science is that the team is an effective innovator (Disis & Slattery, 2010). Team science challenges the conventional “lone investigator” model by recognizing the critical need for providing agency to different individuals for achieving definite success. Diversities in scientific background, team members’ experiences, and their professional networks and views are expected to accelerate the success of impactful and insightful findings through rigorous selection and retention of promising ideas (Singh & Fleming, 2010).

Scientific studies collect data from experiments to assess evidence in favor of or against hypotheses or to develop new hypotheses for future research. Statistics, the science of collecting and studying data, is thus central to all scientific experiments, notably experiments in human biology, health, and medicine. This places the biostatistician as a core member of team science. As the concept of team science gains traction, biostatisticians are increasingly taking on bigger roles in research processes and project management (Perkins et al., 2016). Thus, now is a good time to examine strategies for successful integration of biostatisticians as members of multidisciplinary research teams and ways to enhance and sustain this integration.

## Examples

We have over 50 years of cumulative experience as collaborating biostatisticians in scientific teams of medical studies. Two examples of team science projects from our professional experiences are summarized below.

*Perioperative outcomes research (POR)*: This project examined nationally representative administrative databases to obtain insights into various perioperative outcomes, including morbidity, mortality, and safety of major orthopedic surgeries

(Memtsoudis et al., 2009; Memtsoudis, Besculides, & Mazumdar, 2013). Questions posed by a junior anesthesiologist to a senior PhD statistician about health risks associated with unilateral versus bilateral knee replacement surgery served as a catalyst for a team science effort to address an important research gap in the field of orthopedic surgery. The team consisted of the anesthesiologist (who also had quantitative training at the MPH level), the senior PhD level statistician (who also had experience in administration, finance and supervision), an MD/PhD level epidemiologist, six MS-level statisticians with diverse skill sets (including creating analytic datasets from administrative databases arising from billing, SAS programming and report writing), and a junior PhD-level statistician with interest in statistical methodology development. The team also engaged clinical collaborators from diverse backgrounds to ensure opinions from relevant clinical subject matter (such as surgery, sleep medicine, nutrition, health policy, and economics) were included in the analysis and interpretation of the study results. The senior PhD-level statistician and the anesthesiologist provided joint leadership to the team and secured funds to conduct the study.

*Study of nevi in children (SONIC)*: This is a population-based prospective study of etiology and evolution of nevus phenotypes in preadolescents (Oliveria et al., 2004, 2009). This study team, led by a senior dermatologist who also led the efforts to secure funds to conduct the study, included a diverse group of researchers with expertise in dermatology, skin imaging, melanoma and other cutaneous malignancies, environmental epidemiology, molecular epidemiology, behavioral science, cancer screening and prevention, nursing, and biostatistics. Team members comprised a broad range of career levels, including medical fellows, established researchers and early-career and midcareer researchers. An experienced PhD-level biostatistician, an MS-level biostatistician, and an early-career PhD level environmental epidemiologist constituted a subteam of quantitative experts to provide design and data analysis support.

Both POR and SONIC are team science projects. While the POR team was largely made of biostatistical experts with different types of analytic skills, SONIC included a quantitative subteam embedded within a larger diverse team of scientists. The two projects had different leadership models. POR had a coleader model with quantitative and clinical researchers from different career levels collaborating to form the team and establish vision. SONIC was initiated by a dermatologist with a scientific vision who assembled a diverse team, honed the vision further through collaborative discussions within the team, and included a subteam of quantitative researchers with diverse analytic backgrounds and skills. Despite these organizational differences, POR and SONIC were highly successful team science projects, with success measured in terms of standard academic metrics: multiple peer-reviewed publications, development of statistical methodologies to address novel scientific questions, funding success for multiple disciplines within the team, professional recognition, and novel research directions and career advancements for team members.

It is easy to cite these and other examples and quantify their successes using academic metrics to highlight the value of biostatisticians for the team and, conversely,

the merit of team science collaborations for a biostatistician. However, the specific skills required for a biostatistician to thrive in an integrated research team and what it takes for team leaders to integrate biostatisticians into a highly collaborative and diverse team to move science forward are not immediately apparent (Bennett & Gadlin, 2012). We discuss this below.

## **Characteristics of Successful Teams and Their Biostatistics Members**

Several key skills, when practiced effectively by biostatisticians and other team members, can put the team on a productive path to achieve its scientific objectives and broaden vision for continued scientific advancement and career growth of all team members. Here we focus on four fundamental skills:

1. Leadership;
2. Embracing diversity;
3. Conflict management; and
4. Credit sharing.

These skills can be applied successfully in practice by leveraging three core competencies (Gibson, 2019):

- (a) Active listening;
- (b) Communication; and
- (c) Networking.

## ***Biostatisticians Preparing to Engage in Team Science Projects***

Biostatistics education imparts knowledge in foundational methodologies for experimental design and data analysis, their practical applications, interpretation, report writing, and communication of results to scientists from other disciplines. Biostatisticians getting ready to work in a team science environment need to be cognizant that science is an iterative process. Different team members bring their diverse understanding, perception and priorities to create, innovate and advance science. For a biostatistician, these would mean sitting through multiple meetings and asking questions without inhibitions to understand the crux of the scientific problem, translating this understanding to quantitative terms to determine the study design, identify statistical methods to address scientific hypotheses, educating team members on the pros and cons of different study designs and comparisons being planned, repeating sample size calculations as the scientific objectives continue to evolve until the team finalizes the objectives, developing a statistical analysis plan, explaining this plan to team members, accommodating the input of different team

members, monitoring data accrual and data quality as the study progresses, executing the statistical analysis plan, developing well-annotated computer programs used for data analyses, maintaining different versions of the programs and analysis results, regular discussions with the team to identify and understand previously unforeseen characteristics of the study design or data, identifying or developing novel statistical techniques to accommodate these characteristics, summarizing the analyses for the team, assisting with interpretation, manuscript preparation and responding to reviewers, preparing reports for communicating the results to regulatory agencies and participating in discussions with regulatory agencies, to name a few.

Each of these tasks appear obvious at face value. However, their effective execution requires diligent application of the fundamental skills and the core competencies noted above.

*Leadership:* A biostatistician need not have a designated title as “leader” to practice leadership. In today’s biomedical enterprise, a biostatistician can provide statistical leadership by using influence without authority to guide a multidisciplinary team on adopting valid study design, data analysis, interpretation, and decisions. Active listening allows biostatisticians to hear the viewpoints of team members and provide clear recommendations to advance scientific goals. A biostatistician’s ability to communicate with patience and clarity, to speak up to clarify doubts and to challenge ideas through fair and respectful discussions allows the team to develop confidence in why certain design, analytic methods, and other scientific choices are made. Multidisciplinary teams are often interconnected and typically transcend organizational hierarchies (Bennett et al., 2018). By leveraging such nonhierarchical structures, biostatisticians can establish the following networks to influence the team to adopt statistically rigorous procedures to advance scientific goals—a knowledge network to know who can provide more information; an access network to know how, when, and where to obtain information; and an energy network to draw inspiration and momentum.

*Embracing diversity:* Diversity forms the foundation of team science. The dimensions of a team’s diversity include disciplinary, knowledge, skills, career levels, personality, race/ethnicity, culture, and authority. A diverse environment need not be a harmonious one unless team members commit to transparent exchange of information and cooperate to progress productively in the same problem-solving direction (Bennett et al., 2018). Active listening is crucial for a biostatistician working in a diverse team to learn from the heterogeneous expertise and experiences of other team members. It is not uncommon for a biostatistician to face sensitive situations—for example, different team members may commit to abstract submissions to conferences in diverse disciplines and the onus will fall on the team’s biostatistician(s) to meet exceedingly challenging timelines. This can cause burnout for the biostatisticians and frustration for team members. Sometimes, raw measurements of study subjects may have to be processed to develop interpretable quantitative variables for use in data analysis. The data may not offer clear recommendations on how to do this, and empirical suggestions of team members may not be acceptable to the biostatistician as being statistically rigorous. All



of this can frustrate team members who are looking to the biostatistician for an unequivocal recommendation. Developing the skills to listen and communicate clearly by adapting to the diversity of team members is crucial for biostatisticians to establish the timeline, deliverables and recommendations without coming across as policing the work of other team members (Gibson, 2019). By establishing knowledge, access, and energy networks, biostatisticians can gain expertise in navigating the different forms of diversity present in a team and leverage these diversities to make thoughtful recommendations through constructive discussions with team members, maintain harmony with team members, and gain and retain the respect of the team.

*Conflict management:* Conflict is inevitable and, often, a necessary part of all human interactions. A biostatistician working in a diverse team may face conflicts in many forms. For example, due to the increasing availability of statistical software packages offering data analysis options via drop-down menus, team members who are not properly trained to do data analyses pursue analyses without consulting with the biostatistician. Often, such analyses also use models and methods that are not supported by the data. This leads to disagreement between the biostatistician and the team member conducting the analysis, and to competition and perception that their interests are not compatible. The biostatistician may undergo feelings of insecurity and invisibility and conclude that the team no longer trusts their quantitative competence. Another example is when the team leader is unable to distinguish between collaboration versus consultation and makes sparse use of a biostatistical collaborator's skills—say, a one-time contact with the biostatistician for sample size or power calculation purpose alone without engaging in a long-term partnership involving funding support and collaborative publication. This could also cause conflict and feelings of insecurity and invisibility for the biostatistician. However difficult it may be, it is highly crucial that biostatisticians facing such conflicts forego these negative feelings, take the high road to build and retain their emotional strength, and focus on the team's success by practicing the core competencies. Active listening will allow biostatisticians to understand the culture of the team and contextualize the conflict. Clear communication with team members will allow biostatisticians to acknowledge emotions, identify hidden fears or agendas, and fulfill any unmet quantitative needs of the team. Biostatisticians can then take steps to address and manage these issues with support from their knowledge, access, and energy networks.

*Credit sharing:* This is perhaps the most difficult challenge of team science. Professional recognition is a fundamental research ethic and necessary at all career levels and career paths. There are many ways in which a biostatistician may fail to receive due credit for their contributions. These include lack of credit for data analysis, funding success, or for helping establish scientific goals. For example, multiple quantitative experts may lead the data analysis effort of a project and confusions may arise about the order of authorship placement depicting their levels of contributions. Some team members may view a biostatistician solely as a sample size or power calculator, without realizing the biostatistics discipline includes expertise and skill sets in data analysis, methodology development, and related

software development. Sometimes, a biostatistician's expertise in developing study design and data analysis plans is called upon at the time of grant submission, but he/she may no longer be retained in the team after funding decisions. This issue can occur when the biostatistician is not included as key personnel of the grant and funds initially planned for biostatisticians are reallocated to support trainees or other scientific agenda. Comments made by a biostatistician may have led to novel scientific directions, but the credit may be attributed to team members from other scientific disciplines. These issues are rarely malicious or deliberate. Often, these are simply a consequence of ignorance or lack of clear communication between team members, or team leaders not understanding the need of their roles as "advocates" of statisticians. Active listening and clear communication early on and throughout the biostatistician's interactions with the team is critical for establishing processes and criteria for credit sharing at the outset. These criteria may be revisited by the team regularly. A biostatistician needs to continually expand his/her knowledge, build access to other biostatisticians outside the team for information, and support and develop energy networks to rejuvenate themselves. These activities help a biostatistician to maintain his/her role as a statistical leader of the team and gain advocates from among team members to amplify his/her contributions within and outside the team.

### ***Team Leaders Preparing to Engage Biostatisticians as Collaborators***

Team leaders engaging biostatisticians in multidisciplinary studies carry significant responsibility of ensuring that the biostatisticians are fully integrated into the group and of retaining this integration for an extended duration. This means ensuring that the biostatisticians have a thorough understanding of the study's vision and scientific objectives, the team's diverse skills and experiences, and timelines and all the required resources to conduct their expected tasks, to name a few. Although these sound straightforward, their effective execution requires the team leader(s) to rigorously apply the four key elements and core competencies.

*Leadership:* Successful team leaders recognize their strengths and weaknesses as well as those of their team members. They understand the distinction between collaboration and consultation when engaging biostatisticians as collaborators of team science projects. To this end, successful team leaders are cognizant of the unique strengths that biostatisticians bring to address the scientific goals of their project. They provide agency to the biostatisticians to take statistical leadership of the project and share accountability of the design and analysis choices made. Through active listening, successful leaders are able to identify whether the team's biostatisticians require mentoring and training to better understand the science behind the project and whether team members need training to improve their understanding of statistical concepts so that the entire team can proceed in the

same successful direction. These leaders arrange resources to provide the required training and mentoring, thus raising the knowledge base of the entire study team. They are strong advocates for all the disciplines represented in their team, including biostatistics. Open communication allows team leaders to engage team members in fair and respectful dialogues to understand why certain design and analysis choices are made. By establishing knowledge, access, and energy networks, successful leaders become cognizant of the career paths of the team's biostatisticians, create a safe and productive environment for the biostatisticians to innovate within the context of the team's scientific goals and to achieve career success that would feed back to advance the team's scientific agenda.

*Embracing diversity:* Successful team leaders are acutely aware of the critical role of diversity for scientific progress. These leaders are also aware that quantitative sciences are practiced in multiple scientific disciplines, including biostatistics, epidemiology, and other computational areas. They are also aware that diversity encompasses differences in career levels and career trajectories. Through active listening, successful leaders are able to help biostatisticians thrive in a multi-disciplinary team by setting expectations and establishing responsibilities among different quantitative experts so that everyone feels included and is able to make unique contributions without replication of efforts. Open communication allows team leaders to discuss timelines, arrange resources for biostatisticians to complete analytic tasks in a timely manner, understand the workload of biostatisticians and develop strategies to avoid burnout, and understand data-quality issues and engage different expertise within the team to address these issues. Through their knowledge, access, and energy network, successful leaders are able to understand personality-based and discipline-based differences between group members and create an environment where biostatisticians feel included and visible within a diverse group.

*Conflict management:* Successful team leaders are fully aware that conflicts can be teachable moments. Active listening allows them to continually build trust with team members to recognize conflicts. These leaders do not hesitate to engage in candid communications and, if necessary, have difficult conversations to contain and resolve conflict. They are cognizant of the dangers of relying solely on software packages for data analysis and are acutely aware of the eagerness of some team members to use readily available software packages to conduct their own data analyses. Therefore, successful leaders engage biostatisticians in discussions about appropriate design and analytic strategies and interpretations of data analysis results, regardless of which team member pursued data analyses, thus containing potential conflicts between team members about appropriate analytic approaches, interpretations, and reporting of results. These leaders support biostatisticians in taking statistical leadership of projects. By using their knowledge, access, and energy networks, successful leaders constantly monitor the pulse and climate of their diverse team to create a safe environment where biostatisticians and other team members can thrive.

*Credit sharing:* In many instances, team leaders also have organizational authority—for example as department chairs, program directors, or division chiefs. Thus, they are often aware of shifts in the culture of organizations to give credit

to individual versus team science contributions. There is a growing movement for reflecting the importance of collaboration within clinical and translational team-based science in appointment, promotion, and tenure criteria for disciplines such as biostatistics (Mazumdar et al., 2015). Active listening within and outside the team allows team leaders to document the broad range of contributions of biostatisticians to the team, including team-based scholarship, nontraditional education of team members on statistical concepts, and specialized services such as protocol development and review, data management and methods development to address novel scientific questions, to name a few. Open communication and engaging with their knowledge, access and energy networks within the scientific team and the larger organization allows team leaders to advance the careers of the team's biostatisticians by amplifying the latter's contributions and scientific innovations to their academic supervisors continually and, especially, during promotion.

## Examples Revisited

The fundamental skills and core competencies discussed above allowed the POR and SONIC studies to succeed in their scientific endeavors and strengthened the teams. The coleaders of POR allowed team members to take leadership of different components of the study. For example, the junior PhD-level biostatistician led methodology development to analyze and impute missing data arising within complex surveys and to perform meta-analysis when outcomes were rare or of multivariate nature (Ma & Mazumdar, 2011; Ma, Chu, & Mazumdar, 2016; Ma, Zhang, Lyman, & Huang, 2018). Each MS-level biostatistician took leadership of examining specific national-level databases included in the study to advise the team on types of data that could be extracted and connected with database developers to obtain insights into sampling weights used in complex surveys. To avoid burnout and to align with tracked career growth, roles for MS-level biostatisticians were changed over time by swapping between databases or projects. The PhD-level biostatisticians prepared grants to lead methodology research, which contributed to their career advancement. When the burden of coordinating the team became too heavy for the team leaders, especially around due dates of abstract submission to conferences, steps were taken to change their expectations of submitting to a large number of conferences to a moderate level. Further, the administrative leadership of coordinating team meetings was given to the MS-level statisticians on a rotating basis. Other unrealistic expectations such as requiring the junior PhD-level biostatistician to write clinical manuscripts were addressed and resolved by recruiting a junior PhD-level epidemiologist to lead clinical manuscript preparation.

All team members attained expected promotions at their work with additional recognition for young investigators through an award for the best paper at a scientific meeting (Weill Cornell Medicine, 2010), publication of impactful papers (Danninger et al., 2014; Memtsoudis et al., 2013; Poeran et al., 2014; Stundner et al.,

2012), and awards of federal RO1 grants (AHRQ, 2016). Career development was not just restricted to opportunities within the institutions but when appropriate, team members were advised and assisted to seek career advancement at other institutions, thus keeping the focus on the career growth of the biostatistician. The team also developed a curriculum on POR fellowships for physicians providing training in a wide range of statistical methods and scientific publishing (Memsoudis, Mazumdar, Stundner, & Hargett, 2014). Motivated by the success of this team, leaders shared their experiences through providing guidance to biostatisticians and institutional leaders for making appropriate career choices, for developing optimal biostatistical resources, and for creating appropriate metrics for evaluation of biostatisticians working in the setting of interdisciplinary team-based research (Mazumdar et al., 2015; Perkins et al., 2016; Spratt, Fox, Shara, & Mazumdar, 2017; Welty et al., 2013). Senior members were chosen for team leadership roles of higher complexity and were given opportunity for further leadership training. Finally, the POR team received a prestigious team science award recognizing the team's success in translation of research discoveries, pertaining to perioperative outcomes in orthopedic surgery, into clinical practice (Weill Cornell Medicine, 2012).

The leader of SONIC gave the team's quantitative subgroup the agency to distribute analytic workloads among themselves and to assume leadership of specific analytic tasks according to their quantitative expertise. For example, scientific hypotheses requiring routine analysis methods were led by the MS-level biostatistician or the environmental epidemiologist, while the PhD-level biostatistician provided leadership to statistical genetics and related methods development efforts. These efforts also led to multiple funded statistical genetics research programs, the results of which fed back into the study to strengthen data analysis methods to address the scientific goals. Some senior team members with dermatology and cancer-screening expertise also had quantitative experiences and related publications from their prior works in other studies. The team leader encouraged the quantitative subgroup and other team members to read these publications to understand their unique perspectives, fostered communications among team members, and guided the entire team in leveraging these perspectives and intellectual contributions to develop critical data elements for advancing SONIC's goals. Through regular team discussions, the quantitative subgroup was able to implement these perspectives and develop a uniform set of data elements for this study (Oliveria et al., 2009). The quantitative subteam took leadership of specific data analysis and methodology development tasks that were consistent with their career trajectories—the PhD-level epidemiologist led comprehensive analyses of environmental exposures (Oliveria et al., 2014), the MS-level biostatistician investigated the characteristics of responses to certain survey questions about environmental exposures (Dusza et al., 2012), and the PhD-level biostatistician led the investigation of novel statistical methods for use in the team's genetic studies (Satagopan et al., 2011). When planning authorship, the team leader was cognizant of the career track and duration of training of the team members. Not all team members were authors of all manuscripts emanating from this study. The first author led the scientific investigation, initiated discussions with the quantitative subteam to

plan data analyses, did the bulk of the writing, coordinated manuscript submission, and responded to reviewers. The senior author developed the overarching idea behind the scientific investigation and played a major role in reviewing the work and revising the manuscript. Coauthors were expected to review the scientific hypothesis, provide feedback to help finalize the hypotheses prior to data analysis, review the analysis results, and revise the manuscript contents to make it easily readable to a clinical audience. The team leader's support of the biostatistical contributions of the quantitative subteam also led to several broader recognitions such as a doctoral degree in public health for the MS-level biostatistician and recognition in the professional society as a Fellow for the PhD-level biostatistician.

## Conclusion

Formidable health problems are increasingly addressed by teams of researchers from multiple scientific disciplines, which allows them to combine disconnected ideas and resources to identify solutions (Conn et al., 2019). Biomedical science is generating more data today than ever before, either via carefully designed experiments or via observational investigations. The need to design, collect, and analyze these data, interpret the findings, prepare statistical sections of manuscripts and prepare data sets, data summaries, and statistical programs for broader dissemination has led to a high demand for statistical skills. Together, these needs put biostatisticians at the very center of team science. Biostatisticians can contribute to team science either as leaders of a team or as members of a team led by scientists from other disciplines. Nuanced practice of leadership, accepting diversity, conflict management, and credit sharing are crucial for effective integration of biostatisticians as collaborators of team science projects. The responsibilities of effective and sustained integration lie with biostatistics collaborators of a team as well as team leaders engaging biostatisticians as collaborators. In Table 1 we provide some action items for executing these responsibilities successfully.

The growth of big data has created immense opportunities for diverse groups of quantitative researchers to contribute to biomedical sciences. Today, biostatisticians are not the only quantitative researchers skilled in data analysis. Computer science, data science, systems biology, computational biology, evolutionary biology, and applied mathematics are some of the disciplines contributing to biomedical research in addition to biostatistics. We are also witnessing an era of niche analytic skills for big data such as expertise in handling quality control of deep biomedical data, evaluating metagenomics data for microbiome, conducting pathway analysis for understanding biomolecular functions, analyzing transcription factor binding sites to identify genomic regulators, and using natural language processing and artificial intelligence methods to search for clinical information in electronic medical records, to name a few. A broad range of analytic skills from multiple quantitative disciplines are necessary for addressing the increasing demand for niche research in today's biomedical enterprise. This has caused some concerns about decreasing visibility

**Table 1** Some action plans for successful integration of biostatisticians into team science

Skill	Biostatisticians engaging as collaborators in team science projects	Team leaders from other scientific disciplines engaging biostatisticians as collaborators
Leadership	<ol style="list-style-type: none"> <li>1. Develop self-awareness by recognizing your strengths and limitations</li> <li>2. Familiarize yourself with scientific journals, professional associations and conferences of the team science field of study</li> <li>3. Share responsibility and accountability of all aspects of the team’s work</li> <li>4. Train yourself on the traits of a successful statistician<sup>a</sup></li> <li>5. Give your best every day</li> </ol>	<ol style="list-style-type: none"> <li>1. Understand the difference between biostatistical collaboration versus consultation</li> <li>2. Provide agency to the biostatisticians to do their work</li> <li>3. Be the biostatistician’s advocate by amplifying their contributions within and outside the team</li> <li>4. Be the biostatistician’s mentor and coach and facilitate training in the team science area of study</li> <li>5. Understand the biostatistician’s career path and create a safe and productive environment that aligns with that career path</li> </ol>
Embracing diversity	<ol style="list-style-type: none"> <li>1. Develop other-awareness by recognizing the quantitative skills of team members from different scientific disciplines</li> <li>2. Recognize that different perspectives are essential for scientific success and productivity</li> <li>3. Ask questions and always be prepared to learn from team members</li> <li>4. Be aware of timelines, deliverables, and other expectations</li> <li>5. Establish trust with team members</li> </ol>	<ol style="list-style-type: none"> <li>1. Create an environment where team members recognize and value each other’s skills</li> <li>2. Understand disciplinary, personality, and cultural differences among team members</li> <li>3. Recognize that different disciplines can contribute quantitative skills and that everyone has something important to contribute</li> <li>4. Create an environment for transparent information sharing among team members</li> <li>5. Set expectations, timelines, and deliverables for accomplishing quantitative tasks</li> </ol>

(continued)

**Table 1** (continued)

Skill	Biostatisticians engaging as collaborators in team science projects	Team leaders from other scientific disciplines engaging biostatisticians as collaborators
Conflict management	<ol style="list-style-type: none"> <li>1. Advance the team’s statistical knowledge by educating team members on foundational statistical concepts</li> <li>2. Insist on statistical rigor through fair and respectful communications</li> <li>3. Build allies within the team</li> <li>4. Familiarize yourself with the team’s evolving quantitative needs</li> <li>5. Be willing to collaborate and compromise</li> </ol>	<ol style="list-style-type: none"> <li>1. Understand that conflicts are teachable moments</li> <li>2. Understand the unique skill each quantitative researcher and other members brings to the team</li> <li>3. Be cognizant of the dangers of relying solely on software packages for data analysis</li> <li>4. Listen for content, intent, and feelings of team members to thoughtfully and fairly intervene in conflicts</li> <li>5. Regularly monitor the climate and pulse of the team</li> </ol>
Credit sharing	<ol style="list-style-type: none"> <li>1. Learn about ICMJE<sup>b</sup> authorship criteria and standards developed for statistical contributions</li> <li>2. Understand as early as possible the process and criteria for authorship of manuscripts and credit for successful grant funding</li> <li>3. Understand the many ways through which biostatisticians could contribute to a team and track the contributions you are making</li> <li>4. Build advocates within your team who can amplify your contributions to your supervisors</li> <li>5. Build trust with team members</li> </ol>	<ol style="list-style-type: none"> <li>1. Create agreements for attributing credits for research contributions</li> <li>2. Be mindful of a biostatistician’s career path and career trajectory when developing credit sharing agreements</li> <li>3. Be cognizant of departmental and institutional procedures, policies and processes for assessing a biostatistician’s team science contributions</li> <li>4. Amplify the biostatistician’s contribution outside the team, especially for promotional and other professional recognition</li> <li>5. Create an environment where team members can have open discussions about credit sharing</li> </ol>

<sup>a</sup>See Hahn and Doganaksoy (2012)

<sup>b</sup>International Committee of Medical Journal Editors (2018)

for the statistics profession (Gibson, 2019). The model that the biostatistician is the sole quantitative collaborator and contributor to biomedical research has given way to subteams of experts with diverse analytic training.



To address emerging concerns about declining visibility and anxieties about biostatisticians losing ground to other quantitative disciplines, our profession is adapting an optimistic view and taking steps to develop novel training programs for biostatisticians to prepare them to be leaders and collaborators in team science. Graduate programs are now integrating leadership training and written and oral communication skills development into their curriculum (Buchanich, 2012; LaVange, Sollecito, Steffen, Evarts, & Kosorok, 2012). Topics for these programs include leadership style, written and oral presentation skills, networking skills, professionalism, team management, financial management, and strategic planning, to name a few. Internship opportunities have been developed successfully to provide experience to biostatisticians for engaging in team science research and collaborations right from the undergraduate level (Harvard, 2019; Satagopan & Elkin, 2018). These programs integrate mentored research in multidisciplinary settings with professional development through training in communication, peer discussions, and postprogram mentoring to prepare the next generation of biostatisticians and other quantitative scientists to advance our profession. Several academic institutions are now developing creative graduate programs in data science and analytics through collaborations between multiple stakeholder disciplines—namely, departments of statistics, biostatistics, mathematics, engineering, business, and computer science, to name a few (Pierson, 2019). Due recognition and evaluation of biostatisticians in team science needs to keep pace with the rapidly evolving complexity of research programs. To this end, statisticians in administrative roles have developed recommendations and criteria for documenting team-based scholarship, nontraditional education, and specialized service of biostatisticians collaborating in team science projects (Mazumdar et al., 2015; Moher et al., 2018). By continually evaluating and realigning these efforts to meet the growing needs for statistical skills in biomedical research, we can develop successful strategies to practice fundamental skills and core competencies for biostatisticians to thrive as collaborators in scientific teams.

**Acknowledgments** This work was supported in part by the National Cancer of Institute of the National Institutes of Health through awards R01CA197402, R25CA244071, R25CA214255 and P30CA196521, and the National Institute of Aging of the National Institutes of Health through award P30AG028741. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The authors also acknowledge the POR team (Drs. Stavros Memsoudis, Yan Ma, Jashvant Poeran, Ms. Licia Gaber, Ya-lin Chiu, Xuming Sun, Alison Edwards, Rehana Rasul, and Nicole Zubizarreta) and the SONIC team (Drs. Allan Halpern, Susan Oliveria, Steve Dusza, Irene Orlow, Alon Scope, Michael Marchetti, Ashfaq Marghoob, Marianne Berwick, Martin Weinstock, and Allan Geller) for collegial and productive experiences as statistical leaders and collaborators in team science.

## References

Agency for Healthcare Research and Quality (AHRQ). (2016). *Effect of missing data strategies on disparities research results in HCUP SID*. Retrieved October 11, 2019, from <http://grantome.com/grant/NIH/R01-HS021734-01A1>.

- Bennett, L. M., & Gadlin, H. (2012). Collaboration and team science: From theory to practice. *Journal of Investigative Medicine*, 60(5), 768–775.
- Bennett, L. M., Gadlin, H., & Marchand, C. (2018). *Collaboration and team science: A field guide* (2nd edn.). National Cancer Institute. Retrieved June 14, 2019, from <https://www.cancer.gov/about-nci/organization/crs/research-initiatives/team-science-field-guide>.
- Buchanich, J. M. (2012). Scientific course strengthens students' communication skills. *Amstat News*, 416(7), 6.
- Cancer Genome Atlas Network. (2012). Comprehensive molecular portraits of human breast tumours. *Nature*, 490(7418), 61.
- Cancer Genome Atlas Network. (2015). Comprehensive genomic characterization of head and neck squamous cell carcinomas. *Nature*, 517(7536), 576.
- Cancer Genome Atlas Research Network. (2008). Comprehensive genomic characterization defines human glioblastoma genes and core pathways. *Nature*, 455(7216), 1061.
- Conn, V. S., McCarthy, A. M., Cohen, M. Z., Anderson, C. M., Killion, C., DeVon, H. A., et al. (2019). Pearls and pitfalls of team science. *Western Journal of Nursing Research*, 41, 920–940.
- Danninger, T., Rasul, R., Poeran, J., Stundner, O., Mazumdar, M., Fleischut, P., et al. (2014). Blood transfusions in Total hip and knee Arthroplasty: An analysis of outcomes. *Scientific World Journal*, 14(623460), 1–10.
- Disis, M. L., & Slattery, J. T. (2010). The road we must take: Multidisciplinary team science. *Science Translational Medicine*, 2(22), 1–4.
- Dusza, S. W., Halpern, A. C., Satagopan, J. M., Oliveria, S. A., Weinstock, M. A., Scope, A., et al. (2012). Prospective study of sunburn and sun behavior patterns during adolescence. *Pediatrics*, 129(2), 309–317.
- Forde, P. M., Chaft, J. E., Smith, K. N., Anagnostou, V., Cottrell, T. R., Hellmann, M. D., et al. (2018). Neoadjuvant PD-1 blockade in resectable lung cancer. *New England Journal of Medicine*, 378(21), 1976–1986.
- Gibson, E. W. (2019). Leadership in statistics: Increasing our value and visibility. *The American Statistician*, 73(2), 109–116.
- Hahn, G., & Doganaksoy, N. (2012). *Traits of a successful statistician*. In STATtr@k – A website for new professionals navigating a data-centric world. Retrieved October 29, 2019, from <https://stattrak.amstat.org/2012/06/01/successfulstatistician/>.
- Harvard. (2019). *Summer program in biostatistics & computational biology*. Retrieved October 11, 2019, from <https://www.hsph.harvard.edu/biostatistics/diversity/summer-program/>.
- ICMJE. (2018). *Recommendations for the conduct, reporting, editing and publication of scholarly work in medical journal*. Retrieved October 29, 2019, from <http://www.icmje.org/icmje-recommendations.pdf>.
- Kreimer, A. R., González, P., Katki, H. A., Porras, C., Schiffman, M., Rodriguez, A. C., et al. (2011). Efficacy of a bivalent HPV 16/18 vaccine against anal HPV 16/18 infection among young women: A nested analysis within the Costa Rica vaccine trial. *The Lancet Oncology*, 12(9), 862–870.
- LaVange, L., Sollecito, W., Steffen, D., Evarts, L., & Kosorok, M. (2012). Preparing biostatisticians for leadership opportunities. *Amstat News*, 416, 5–6.
- Ma, Y., Chu, H., & Mazumdar, M. (2016). Meta-analysis of proportions of rare events: A comparison of exact likelihood methods with robust variance estimation. *Communications in Statistics: Simulation and Computation*, 45(8), 3036–3052.
- Ma, Y., & Mazumdar, M. (2011). Multivariate meta-analysis: A robust approach based on the theory of the U-statistic. *Statistics in Medicine*, 30(24), 2911–2929.
- Ma, Y., Zhang, W., Lyman, S., & Huang, Y. (2018). The HCUP SID imputation project: Improving statistical inferences for health disparities research by imputing missing race data. *Health Services Research*, 53(3), 1870–1889.
- Mazumdar, M., Messinger, S., Finkelstein, D. M., Goldberg, J. D., Lindsell, C. J., Morton, S. C., et al. (2015). Evaluating academic scientists collaborating in team-based research: A proposed framework. *Academic Medicine: Journal of the Association of American Medical Colleges*, 90(10), 1302.

- Memtsoudis, S. G., Besculides, M. C., & Mazumdar, M. (2013). Rude awakening — The perioperative sleep apnea epidemic. *New England Journal of Medicine*, *368*(25), 2352–2353.
- Memtsoudis, S. G., Ma, Y., Della Valle, A. G., Mazumdar, M., Gaber-Baylis, L. K., MacKenzie, C. R., et al. (2009). Perioperative outcomes after unilateral and bilateral total knee arthroplasty. *Anesthesiology: The Journal of the American Society of Anesthesiologists*, *111*(6), 1206–1216.
- Memtsoudis, S. G., Mazumdar, M., Stundner, O., & Hargett, M. J. (2014). Perioperative research fellowship: Planning, implementation, experience. *Regional Anesthesia and Pain Medicine*, *39*(5), 363–367.
- Moher, D., Naudet, F., Cristea, I. A., Miedema, F., Ioannidis, J. P., & Goodman, S. N. (2018). Assessing scientists for hiring, promotion, and tenure. *PLoS Biology*, *16*(3), e2004089.
- Oliveria, S. A., Geller, A. C., Dusza, S. W., Marghoob, A. A., Sachs, D., Weinstock, M. A., et al. (2004). The Framingham school nevus study: A pilot study. *Archives of Dermatology*, *140*(5), 545–551.
- Oliveria, S. A., Satagopan, J. M., Geller, A. C., Dusza, S. W., Weinstock, M. A., Berwick, M., et al. (2009). Study of Nevi in Children (SONIC): Baseline findings and predictors of nevus count. *American Journal of Epidemiology*, *169*(1), 41–53.
- Oliveria, S. A., Scope, A., Satagopan, J. M., Geller, A. C., Dusza, S. W., Weinstock, M. A., et al. (2014). Factors associated with nevus volatility in early adolescence. *The Journal of Investigative Dermatology*, *134*(9), 2469.
- Perkins, S. M., Bacchetti, P., Davey, C. S., Lindsell, C. J., Mazumdar, M., Oster, R. A., et al. (2016). Best practices for biostatistical consultation and collaboration in academic health centers. *The American Statistician*, *70*(2), 187–194.
- Pierson, S. (2019). New Master's or Doctoral data science and analytics program II. *Amstat News*. Retrieved October 11, 2019, from <https://magazine.amstat.org/blog/2019/01/02/new-masters-or-doctoral-data-science-and-analytics-programs-ii/>.
- Poeran, J., Rasul, R., Suzuki, S., Danninger, T., Mazumdar, M., Opperer, M., et al. (2014). Tranexamic acid use and postoperative outcomes in patients undergoing total hip or knee arthroplasty in the United States: Retrospective analysis of effectiveness and safety. *BMJ*, *349*(g4829), 1–10.
- Satagopan, J. M., & Elkin, E. (2018). The Quantitative Sciences Undergraduate Research Experience (QSURE) program at Memorial Sloan Kettering Cancer Center – Experiences from the inaugural year. In *International Cancer Education Conference*. Retrieved October 1, 2019, from <https://www.aaceonline.com/docs/ICEC/2018/Abstracts/ICEC.2018.Abstracts.Session4A.pdf>.
- Satagopan, J. M., Zhou, Q., Oliveria, S. A., Dusza, S. W., Weinstock, M. A., Berwick, M., et al. (2011). Properties of preliminary test estimators and shrinkage estimators for evaluating multiple exposures—Application to questionnaire data from the ‘Study of nevi in children’. *Journal of the Royal Statistical Society: Series C (Applied Statistics)*, *60*(4), 619–632.
- Singh, J., & Fleming, L. (2010). Lone inventors as sources of breakthrough: Myth or reality? *Management Science*, *56*(1), 41–56.
- Spratt, H., Fox, E. E., Shara, N., & Mazumdar, M. (2017). Strategies for success: Early-stage collaborating biostatistics Faculty in an Academic Health Center. *The American Statistician*, *71*(3), 220–230.
- Stundner, O., Chiu, Y. L., Sun, X., Mazumdar, M., Fleischut, P., Poultsides, L., et al. (2012). Comparative perioperative outcomes associated neuraxial versus general anesthesia for simultaneous bilateral total knee arthroplasty. *Regional Anesthesia and Pain Medicine*, *37*(6), 638–644.
- Weeks, W. B., Wallace, A. E., & Kimberly, B. S. (2004). Changes in authorship patterns in prestigious US medical journals. *Social Science & Medicine*, *59*(9), 1949–1954.
- Weill Cornell Medicine. (2010). *Dr. Yan Ma to receive Statistics in Epidemiology Young Investigator Award by the American Statistical Association for the best paper focusing on inference for kappa statistic in a longitudinal data setting*. Retrieved October 11, 2019, from [http://www.hitecny.org/about\\_us/2010\\_8\\_honors.html](http://www.hitecny.org/about_us/2010_8_honors.html).

- Weill Cornell Medicine. (2012). *Cross-Institutional, Interdisciplinary Research Team Wins Prestigious Award for Collaboration*. Retrieved October 11, 2019, from <https://news.weill.cornell.edu/tags/team-science-award>.
- Welty, L. J., Carter, R. E., Finkelstein, D., Harrell Jr., F. E., Lindsell, C. J., Macaluso, M., et al. (2013). Strategies for developing biostatistics resources in an academic health center. *Academic Medicine*, 88(4), 454–460.
- Wuchty, S., Jones, B. F., & Uzzi, B. (2007). The increasing dominance of teams in production of knowledge. *Science*, 316(5827), 1036–1039.
- Zauber, A. G., Winawer, S. J., O'Brien, M. J., Lansdorf-Vogelaar, I., van Ballegoijen, M., Hankey, B. F., et al. (2012). Colonoscopic polypectomy and long-term prevention of colorectal-cancer deaths. *New England Journal of Medicine*, 366(8), 687–696.

# Inclusive Leadership Across Cultures and Cultural Intelligence at Home



James J. Cochran

**Abstract** We discuss ways to address challenges that arise when leading a team of highly educated volunteers from a wide variety of cultures. We use initiatives that rely on volunteers (Teaching Effectiveness Colloquia, *Wiley Encyclopedia of Operations Research and Management Science*, and *INFORMS Transactions on Education*) to provide examples for discussion.

## Introduction

Leading a team of highly educated volunteers from a wide variety of cultures can be extremely perplexing and challenging. So why bother? First, we must appreciate that leading such a team can also be extremely illuminating, gratifying, and inspiring (often while simultaneously being extremely perplexing and challenging). Second, we must understand that this is the best (or perhaps in some instances, the only) path to developing a particular initiative, resolving a unique problem, or confronting and resolving a challenging crisis. Such teams can provide all involved with tremendous professional and personal growth opportunities.

In this chapter, I discuss my perspectives on leading teams of highly educated volunteers from a wide variety of cultures. In section “[Three Initiatives that Rely Heavily on Volunteers](#)”, I open by discussing three initiatives in which I have been heavily involved that have necessitated that I lead such teams. I discuss a definition of leadership and framework for classifying leadership styles in section “[What Is Leadership?](#)”. In section “[Leadership and Consideration of Cultures, Education Levels, and Volunteerism](#)”, I outline a process for finding a leadership style that will bridge cultural distances, and I discuss how this process led me to determine the most appropriate leadership style for the three initiatives discussed in section “[Three Initiatives that Rely Heavily on Volunteers](#)”. In section “[Lessons from Icons](#)”

---

J. J. Cochran (✉)

Culverhouse College of Business, The University of Alabama, Tuscaloosa, AL, USA  
e-mail: [jcochran@cba.ua.edu](mailto:jcochran@cba.ua.edu)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,  
[https://doi.org/10.1007/978-3-030-60060-0\\_5](https://doi.org/10.1007/978-3-030-60060-0_5)

of Leadership”, I share relevant lessons I have learned from a few great leaders from history. I provide brief concluding remarks in section “Conclusions”.

### Three Initiatives that Rely Heavily on Volunteers

For several years, I have worked on numerous initiatives designed to improve understanding and expand application of statistics, operations research, and analytics, primarily in developing nations. These three initiatives combine to serve as an excellent backdrop for a discussion of leadership across cultures—both domestic and international—with a focus on working with teams composed of highly educated volunteers.

#### *Teaching Effectiveness Colloquia*

The first of the three initiatives we will use as a basis for this discussion of leadership is the *Teaching Effectiveness Colloquia* or *TEC* (Cochran, 2009, 2012; Rossman & Cochran, 2018). Through the TEC, academic colleagues from statistics, operations research, and analytics come together to (1) demonstrate and share innovative and effective approaches to teaching statistics, operations research, and analytics concepts across cultures and (2) encourage the application of the tools of statistics, operations research, and analytics to humanitarian issues and societal challenges. This initiative, originally developed in the late 1990s for audiences in the USA and Canada, was extended internationally in 2006. Countries in which I have worked with various colleagues and professional societies to organize these events include:

- Montevideo, Uruguay, in 2006 at the XIII CLAIO Latin Ibero-American Conference on Operations Research
- Cape Town, South Africa, in 2007 at the 37th Annual Conference of the Operations Research Society of South Africa
- Cartagena de Indias, Colombia, in 2008 at the XIV CLAIO Latin Ibero-American Conference on Operations Research
- Dar es Salaam, Tanzania, in 2009 at the fifth International Operations Research of Eastern Africa Conference
- Jaipur, India, in 2009 at the Conference of the Asia-Pacific Operations Research Society
- Buenos Aires, Argentina, in 2010 at the XV CLAIO Latin Ibero-American Conference on Operations Research
- Nairobi, Kenya, in 2011 at the sixth International Operations Research of Eastern Africa Conference

- Suva, Fiji, in 2011 at the first International Conference for Health Statistics in the Pacific Islands
- Buea, Cameroon, in 2013 at the third Buea Conference on Mathematical Sciences
- Bharatpur, Nepal, in 2014 at the Annual Conference of the Operational Research Society of Nepal
- Osijek, Croatia, in 2014 at the 15th International Conference on Operational Research KOI
- Havana, Cuba, in 2015 at the 11th International Workshop on Operations Research
- Ulaanbaatar, Mongolia, in 2016 at the Conference on Applied Statistics: Teaching, Research, and Business Innovation
- Chişinău, Moldova, in 2017 at the fourth Conference of the Mathematical Society of the Republic of Moldova
- Tunis, Tunisia, in 2018 at the first International Conference of the African Federation of Operational Research Societies
- Sozopol, Bulgaria, in 2019 at the 44th International Conference on Applications of Mathematics in Engineering and Economics
- St. George's, Grenada, in 2019 with the Partnership in Statistics for Development in the twenty-first century (PARIS21)

In these colloquia, we feature several speakers/short workshops on how to make applied mathematics education (particularly statistics, operations research, and analytics) more effective. We may discuss teaching with technology, issues in distance learning, collaborative learning, active learning, writing and teaching with cases, project-based learning, dealing with the challenges of large classes, teaching modeling skills, etc. We also strive to (1) incorporate workshops by members of the host organization and (2) assist the host organization in augmenting its organizational and conference structure to accommodate its members who are concerned with the quality of applied mathematics education. These TEC are a terrific way to share across cultures and establish working relationships.

### ***The Wiley Encyclopedia of Operations Research and Management Science***

The second of the three initiatives we will use as a basis for this discussion on leadership is the *Wiley Encyclopedia of Operations Research and Management Science* (EORMS, <http://www.wiley.com/WileyCDA/Section/id-380199.html>). EORMS (Cochran, Anthony, Keskinocak, Kharoufeh, & Smith, 2011), which was published in February of 2011 and for which I serve as the founding Editor in Chief, is an eight volume, 6000+ page reference comprising over 600 articles written by eminent scholars that provides a great deal of valuable support to colleagues teaching and using ORMS.

An unparalleled undertaking, *EORMS* is the first multivolume encyclopedia devoted to advancing the areas of operations research and management science. *EORMS* includes a broad and carefully structured coverage of mathematical theory, algorithms, modeling, and application issues in operations research and management science. The encyclopedia features contributions from diverse and international contributors from academia, industry, business, government, and the military (Cochran, 2011).

This resource has been designed for academic researchers and advanced students as well as professionals looking for timely and authoritative review-type information in this field. Colleagues and students make great use of the content of this reference—the articles can be used in classrooms, on applications of operations research/management science, as references for research, and as a source for further literature review (the articles generally have extensive bibliographies). Many users have indicated that they have found this resource to be of great value.

In addition to the print version of the encyclopedia, we have also produced and are maintaining an online version of *EORMS*. The dynamic online presence allows for linking to primary literature and other online resources. Through a systematic program of quarterly updates, which maintain the currency of the encyclopedia's content, *EORMS* grows and evolves along with the field itself, ensuring that it remains a mainstay of operations research and management science.

The online version of *EORMS* is available to mathematicians, statisticians, and operations researchers in developing nations for free or at a greatly reduced cost through Research4Life (<http://www.research4life.org/>). Eligible institutions in qualified countries include universities and colleges, research institutes, professional schools, extension centers, government offices, local nongovernmental organizations (NGOs), hospitals, and national libraries.

Articles are written at one of four levels so that readers at all levels can access its content:

- Introductory Articles provide a broad and moderately technical treatment of core topics and are suitable for advanced undergraduate students as well as scientists without a strong background in the field.
- Advanced Articles review key areas of research in a citation-rich format similar to that of leading review journals. These articles are updated regularly ensuring the most up-to-date research in the field is represented.
- Technical Articles provide more detailed discussions of key concepts addressed in related articles.
- Case Studies/Historical Interludes present successful and/or interesting examples of operations research/management science methodology in practical or historical contexts.

Each article is reviewed by two experts in the subject matter who have been identified by the associated Topical Editor. Each submission is reviewed for:

- Content—are all of the appropriate subtopics covered?
- Clarity—is the article readable?



- Conciseness—does the author avoid unnecessary detail?
- Completeness—is the discussion reasonably comprehensive?
- Correctness—is the article accurate?

Once these reviews are complete, the Topical Editor makes a recommendation to the associated Area Editor. The Area Editor then makes a provisional decision, which is finalized by the Editor.

### ***INFORMS Transactions on Education***

Finally, the third of the three initiatives we will use as a basis for this discussion is *INFORMS Transactions on Education (ITE)*, a journal for which I served as Editor in Chief from 2007 to 2012. *ITE*, which is published by the Institute for Operations Research and the Management Sciences (INFORMS), is a peer-reviewed academic journal devoted solely to issues in operations research and management science education that is freely available online ([www.informs.org/Journal/ITE](http://www.informs.org/Journal/ITE)). In addition to articles on issues in operations research and management science education, *ITE* publishes teaching cases with accompanying teaching notes. The cases are freely available (so resource-poor instructors can provide their students with the URL rather than distribute printed copies), while the teaching notes are stored in a password-protected site to prevent students from gaining access to these documents (instructors can contact INFORMS to request a password). During one 7-month period, *ITE* had 11,667 visits to its website from 139 countries, and the journal fields several requests weekly from all over the world for access to its password-protected teaching notes site.

### ***A Note on Coordination Across the Three Initiatives***

In an additional layer of complexity, I have tried to coordinate these initiatives so they would provide our colleagues in developing nations with course content (through *EORMS*), classroom support material (through *ITE*), and discussion of teaching methods/establishment of relationships between statistics, operations research, and analytics educators across cultures (through the TEC and *ITE*). In doing so, the overriding objectives are to (1) help grow statistics and operations research education societies in developing nations, (2) encourage the application of statistics/operations research/analytics to address societal issues, and (3) encourage the development of collaborative relationships across the worldwide statistics, operations research, and analytics communities.

## What Is Leadership?

My definition of leadership is deceptively simple: it is the ability to get people to work through their differences to cooperatively determine common objectives, establish a procedure for achieving these objectives, and execute the procedure in order to accomplish these objectives. This definition has several important nuances:

- *...the ability to get people to...* implies that leaders do not work in a solitary manner and that leadership does not occur in a vacuum—to be a leader, one must work with others.
- *...work through their differences...* suggests that obstacles will inevitably develop and conflicts will certainly occur when addressing any complex task, and a leader helps those she or he is leading overcome these obstacles and resolve these conflicts.
- *...to cooperatively determine objectives, establish a procedure for achieving these objectives, and execute the procedure...* infers that a leader facilitates her or his team’s efforts to identify the problem to be resolved, evaluate and select solution methodologies, and develop strategies for implementing and maintaining the solution that is developed.
- *...in order to accomplish these objectives...* intimates that a leader is not successful unless the group she or he is leading accomplishes the objectives it sets forth.

However, it is important to note that the word *leadership* is extremely personal, and an individual’s definition of *leadership* reflects her or his outlook and experience (we will consider the perspectives of two important leaders from the twentieth century in section “[Lessons from Icons of Leadership](#)” of this chapter). If members of a team do not share a relatively common definition of leadership, the leader of the team will likely face additional challenges that may be difficult to anticipate or identify. Thus, when leading a team comprising members with diverse outlooks and a wide array of experiences, proper consideration of differences in how team members define leadership is a critical factor in the success of a team endeavor.

Almost by definition, teams that include members from several cultures do present diverse outlooks and wide arrays of experiences, and so exhibit the associated difficulties. Effective leaders understand their own strengths and weaknesses, recognize and are sensitive to the team members’ outlooks and experiences, have command of a wide variety of leadership styles, and utilize a leadership style that is suited to the members of her or his team and the objectives the team is striving to accomplish.

Experts in leadership theory generally cite as few as four and as many as ten leadership styles. I see these styles as falling on two broad dimensions: *team member freedom* or the level of freedom the team leader wants to give her or his team members to accomplish their tasks, and *team member engagement* or the level of engagement in the team’s strategic efforts the leader wants from her or his team members.

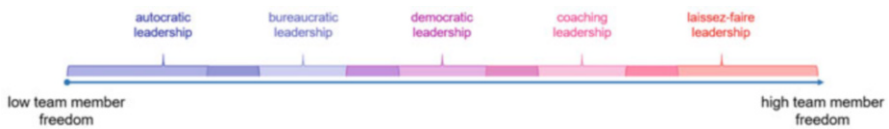
### ***Leadership: Team Member Freedom Dimension***

Leadership styles on the *team member freedom* dimension (from low engagement to high engagement) include:

- **Autocratic Leadership**—an autocratic leader makes all decisions, perhaps with input from a small group of trusted team members or other colleagues. Although this can be a very efficient style, it tends to limit the contributions of team members, fail to take advantage of potential team member synergies, and constrict the team’s creativity and innovative impulses.
- **Bureaucratic Leadership**—a bureaucratic leader establishes clear team rules, team procedures, team member responsibilities, and team member duties. This can be a very efficient style that allows team members to contribute, but it may fail to take advantage of potential team member synergies, and it may constrict the team’s creativity and innovative impulses.
- **Democratic Leadership**—a democratic leader solicits and considers input from all team members. This can be an inefficient style that may not fully leverage the team’s creativity and innovative impulses, but it also can engage team members and encourage greater synergism among team members.
- **Coaching Leadership**—a coaching leader identifies team members’ strengths, weaknesses, and motivations and uses this knowledge to help each individual contribute to accomplishment of the team’s objectives. Although this can be an inefficient style, it can leverage the team’s creativity and innovative impulses, engage team members, and encourage greater synergism among team members.
- **Laissez-faire Leadership**—a laissez-faire leader acts as a coordinator of team efforts, delegating tasks to various team members and providing relatively little direct supervision. Although this can be an inefficient style that may not engage team members or encourage greater synergism among team members, this style can take advantage of skills of members of very diverse teams and encourage the team’s creativity and innovative impulses.

These styles should not be thought of as distinct categories, but rather as positions on the *team member freedom* dimension.

As Fig. 1 implies, there are varying degrees of styles on the team member freedom dimension, and they are not mutually exclusive—they do overlap. It is, for example, conceivable that a leader could adopt a bureaucratic leadership style with some elements of a democratic leadership style.



**Fig. 1** Team member freedom dimension



**Fig. 2** Team member engagement dimension

### ***Leadership: Team Member Engagement Dimension***

Leadership styles on the *team member engagement* dimension (from individual task to team objective) include:

- **Pacesetter Leadership**—a pacesetter leader strives to accomplish the team’s objective(s) by establishing a series of specific, relevant, and coordinated goals for members of the team. This approach does not give the team members a great deal of independence.
- **Transformational Leadership**—a transformational leader endeavors to accomplish the team’s objective by encouraging each team member to focus on the team’s overarching objective(s). This approach gives the team members some independence.
- **Visionary Leadership**—a visionary leader relies heavily on the power of a novel, imaginative, and/or inspiring insight into objective(s) the team is striving to accomplish. This approach gives the team members a great deal of independence and requires the leader to be an exceptional and particularly diligent communicator.

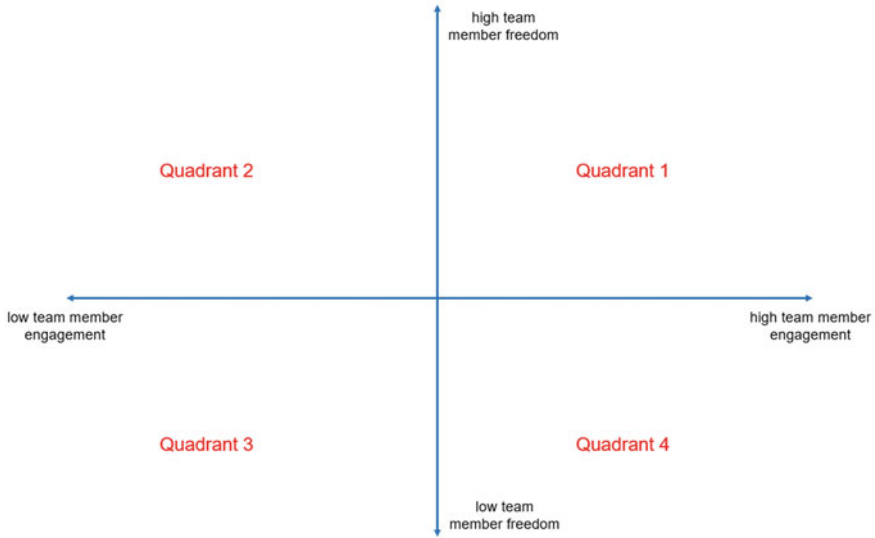
As Fig. 2 implies, there are varying degrees of styles on the team member engagement dimension, and they are not mutually exclusive—they do overlap. It is, for example, conceivable that a leader could adopt a visionary leadership style with some elements of a transformational leadership style.

### ***The Leadership Space***

Using these two dimensions, we can create a map of the space that leaders can occupy.

Each quadrant in Fig. 3 captures a unique general profile of leadership style, and the distance a leader’s style is from the origin conveys how extreme a leader is on the associated dimensions.

- Leaders whose style falls in the first quadrant tend to include team members in the team’s strategic efforts and give the team members a great deal of latitude in how they contribute.



**Fig. 3** The leadership space

- Leaders whose style falls in the second quadrant tend to delegate specific tasks to team members but give the team members a great deal of latitude in how they accomplish their assigned tasks.
- Leaders whose style falls in the third quadrant tend to delegate specific tasks to team members and give the team members little latitude in how they accomplish their assigned tasks.
- Leaders whose style falls in the fourth quadrant tend to include team members in the team’s strategic efforts but give the team members relatively little latitude in how they contribute.

Although most leaders typically rely on a primary style, most effective leaders do not utilize a single style exclusively. They recognize that choosing the most appropriate leadership style (or combination of styles) for the problem to be addressed and the team to be led tends to improve the likelihood of team success in resolving the problem. These leaders vary their styles to fit the problem to be addressed, the team member’s personalities and skills, the team’s objectives, and the team’s experiences. They also consider how these factors might interact with each other. This is sometimes a deliberate and conscious decision, but often it is not so; a leader may react to these factors without thinking specifically about them, especially if she or he has a great deal of experience as a leader and/or is under a great deal of stress with regard to addressing the problem at hand.

## **Leadership and Consideration of Cultures, Education Levels, and Volunteerism**

Getting people to work through their differences to cooperatively determine common objectives, establish a procedure for achieving these objectives, and execute the procedure in order to accomplish these objectives can be difficult under the best of circumstances. Even when team members share a common cultural background, differences in their experiences and expectations can lead to schisms that are difficult to overcome. When *cultural differences*, *education levels*, and *volunteerism* are added to this mix, the likelihood for misunderstandings and the likelihood that misunderstandings will mushroom into breaks in the cohesiveness of the team increase dramatically.

To reduce the likelihood of these misunderstandings and their potentially damaging impact on team cohesiveness, the effective leader must think purposefully about building and managing her or his team. This requires that consistent attention be devoted to the following issues throughout the development and life of the team:

- Direction
  - What are the objectives the team is working toward?
  - What are the critical tasks in achieving these objectives?
- Planning
  - What is the critical path for these tasks?
- Organization
  - Which team members are assigned to these tasks?
- Communication
  - Why have team members been assigned to their respective tasks?
  - How does the achievement of the team's objectives lead to/contribute to realization of the targeted outcomes/end results?
  - How will these team members contribute to the realization of the targeted outcomes/end results?
  - How will the team members know that the targeted outcomes/end results have been realized?

Consideration of these issues in conjunction with the leader's personality are necessary steps to maximizing the likelihood of team success.

### ***Leadership and Consideration of Cultures***

A lack of understanding of cultural differences can result in myriad team misunderstandings and friction. For example, the role of leader implies a hierarchy. Some

cultures have stronger hierarchical orientations; team members from these cultures expect and more readily take guidance from superiors, prefer clearly defined roles with boundaries and limitations, observe rules and guidelines, and rarely challenge the team leader(s). Other cultures have stronger egalitarian orientations; team members from these cultures prefer to work independently with relatively little guidance or direction from the team leader(s), appreciate flexibility and latitude in team member roles, make their own judgments with regard to rules and guidelines, and are willing to challenge the team leader(s). Thus, team members from different cultures may react differently to the notion of hierarchy.

Acceptance of a leader's willingness to take risks is another factor that differs across cultures; some cultures favor leaders who are risk averse, and other cultures have an appreciation for leaders who are risk affinitive. Still another factor is the preferred communication style. Some cultures prefer leaders to be direct when communicating with team members; team members from these cultures tend to be more concerned with what is actually said than with the nuance of how something is said (including nonverbal cues), are willing to openly confront difficult issues, and rely on the speaker to say what she or he means. Other cultures prefer an indirect communication style; team members from these cultures tend to pay close attention to the nuances of how something is communicated (including nonverbal cues), prefer to avoid direct confrontation, appreciate tact and diplomacy, and rely on the listener to interpret meaning.

Such differences can create what Kogut and Singh refer to as cultural distance—“... the overall difference in national culture between the home country and affiliates overseas...” (Kogut & Singh, 1988). To successfully lead a multicultural team, one must possess and exercise the capacity to recognize and effectively work through cultural distance throughout the process outlined in the introduction to section “[Leadership and Consideration of Cultures, Education Levels, and Volunteerism](#)” of this chapter. We considered each of these issues deliberately when assembling the international team that would create the first edition of *EORMS*.

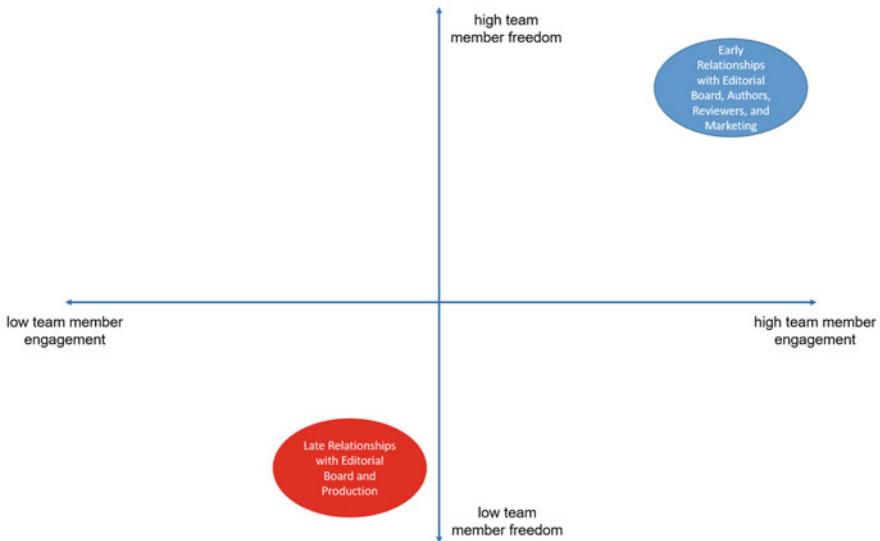
- By first defining the objectives the team would work toward (the simultaneous development of a print and an online comprehensive encyclopedia of operations research and management science), we could provide prospective team members with a clear indication of what we wanted to accomplish.
- Identification of the tasks that would be critical in achieving these objectives helped prospective team members understand the scope and magnitude of the objectives.
- Establishing the critical path for these tasks conveyed the necessary commitment to prospective team members.
- Identifying which team members would be assigned to these tasks and explaining how achievement of the team's objectives would lead to/contribute to realization of the targeted outcomes/end results communicated how prospective team members would interact.
- Explaining why prospective team members would be assigned to their respective tasks and how prospective team members would contribute to the realization of

the targeted outcomes/end results enabled prospective team members understand and appreciate their roles on the team.

- Detailing how the achievement of the team’s objectives will lead to/contribute to realization of the targeted outcomes/end results and how will the team members know that the targeted outcomes/end results have been realized enables prospective team members to appreciate the opportunity of joining the team.

Consideration of these issues and the unique facets of the *EORMS* project throughout the process outlined in the introduction to section “**Leadership and Consideration of Cultures, Education Levels, and Volunteerism**” of this chapter led me to conclude that *EORMS* would be most likely to succeed and I be most effective as editor if I generally utilized a leadership style from the first quadrant of Fig. 3. That is, engaging heavily with team members and giving them a great deal of freedom (especially in the early/creative phase of the project) would be critical to my success as a leader and success of the *EORMS* project. This process also led me to recognize that, because of the pace at which *EORMS* was being created, there would be instances in which I would have to utilize a leadership style from the third quadrant of Fig. 3, engaging relatively little with team members and giving somewhat less freedom (especially in the late/production phase of the project) (Fig. 4).

Although active and consistent consideration of these issues certainly reduces the likelihood of team misunderstandings, friction did occasionally occur. *EORMS* required the establishment of three layers of team membership—one editor-in-chief, four area editors, and over 30 topical editors from around the globe—who would



**Fig. 4** *EORMS* and the leadership space



work with over 1500 authors and over 1500 reviewers throughout the international operations research and management science community to create a large major reference work in less than 3 years. So, some degree of misunderstanding and resulting friction was unavoidable. But without the preparation and consideration discussed in the previous sections, these issues would have almost certainly occurred more frequently and been more profound.

A leader must also recognize that no matter how much consideration she or he devotes to these issues, it is virtually impossible to reduce the likelihood of misunderstandings among team members to zero. It is imperative that the leader actively seek out and embrace these misunderstandings, and she or he must use them as opportunities for the team and its members to learn, grow, and ultimately become more cohesive. In the case of *EORMS*, through active and positive management of the misunderstandings and friction, we were able to greatly improve and streamline our processes and develop new topics for entries in the encyclopedia.

I have taken similar approaches to developing and organizing the Teaching Effectiveness Colloquia and augmenting the editorial board of *INFORMS Transactions on Education*. In each initiative, I am confident that active and consistent consideration of the issues discussed early in this section reduced the frequency and urgency of the team misunderstandings and friction that did occasionally occur.

### ***Leadership and Consideration of Education Levels***

In each of the three initiatives (the Teaching Effectiveness Colloquia, *EORMS*, and *INFORMS Transactions on Education*) discussed as examples in this chapter, the teams in question were populated almost entirely by highly successful professionals and academics who had earned graduate degrees. For example, every member of the *INFORMS Transactions on Education* editorial board is a successful academic researcher and instructor who holds a Ph.D. in a technical discipline such as operations research, management science, statistics, or mathematics. These individuals have strong opinions about their disciplines of study, and in their roles as Associate Editors they are expected to express these opinions.

Editorial board members: Consideration of these issues and the unique facets of the *INFORMS Transactions on Education* project throughout the process outlined in the introduction to section “[Leadership and Consideration of Cultures, Education Levels, and Volunteerism](#)” of this chapter led me to conclude that *INFORMS Transactions on Education* would be most likely to succeed and I be most effective as editor if I generally utilized a leadership style from the first quadrant of Fig. 3. That is, providing these editorial board members with heavy opportunity for engagement and giving them a moderate amount of freedom would be critical to my success as a leader and success of *INFORMS Transactions on Education*.

Authors of manuscripts: Authors submitting to *INFORMS Transactions on Education* are also generally holders of the Ph.D. in technical disciplines, and they are the ultimate creators of the content of the journal. Consideration of these

issues and the unique facets of *INFORMS Transactions on Education* throughout the process outlined in the introduction to section “[Leadership and Consideration of Cultures, Education Levels, and Volunteerism](#)” of this chapter led me to conclude that they therefore would best be led in a manner that differs from the members of the Editorial Board. I would be most effective as editor if I generally utilized a leadership style from the second quadrant of Fig. 3, providing these team members with relatively little opportunity for engagement and giving them a great deal of freedom.

Reviewers of manuscripts: Although reviewers submitted to *INFORMS Transactions on Education* are also generally holders of the Ph.D. in technical disciplines, the nature of their contributions differs a great deal from the contributions made by the editorial board members and authors. Consideration of these issues and the unique facets of *INFORMS Transactions on Education* throughout the process outlined in the introduction to section “[Leadership and Consideration of Cultures, Education Levels, and Volunteerism](#)” of this chapter led me to conclude that they therefore would also best be led in a manner that differs from the members of the Editorial Board. I would be most effective as editor if I generally utilized a leadership style from the fourth quadrant of Fig. 3, providing these team members with relatively high engagement and giving them relatively little freedom (Fig. 5).

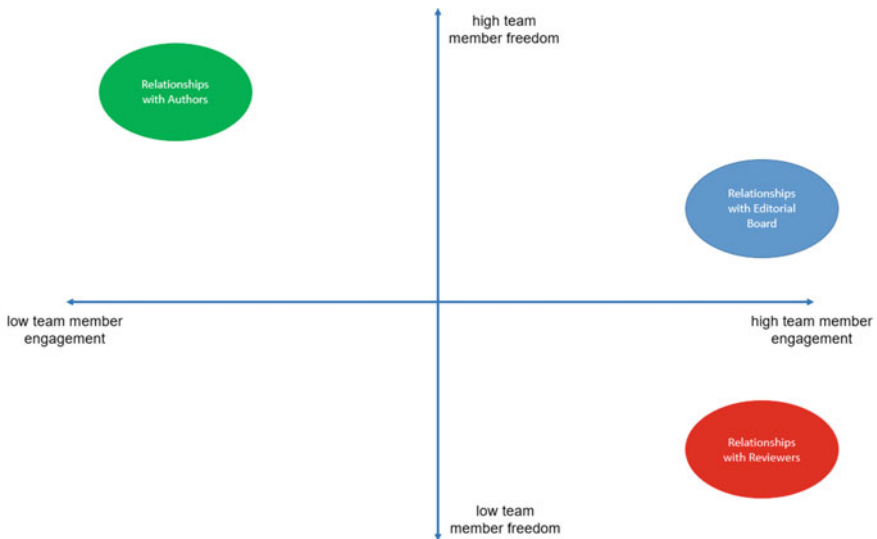


Fig. 5 *INFORMS Transactions on Education* and the leadership space

## ***Leadership and Consideration of Volunteerism***

In each of three initiatives (the Teaching Effectiveness Colloquia, *EORMS*, and *INFORMS Transactions on Education*) discussed as examples in this chapter, the teams in question were populated almost entirely by volunteers who had a variety of motives for participating. Volunteers freely give their time, effort, and energy to help accomplish something they feel is important. They are not compensated monetarily for their efforts (they may be foregoing the opportunity to earn money or may even spend some of their own money in their volunteer efforts). Because they are not compensated monetarily, some volunteers do not feel a strong commitment to the team (in some developing nations, this may be also because they have to do much more to provide for their families). Thus, volunteers can be unreliable and perform inconsistently, and they can easily become disengaged.

An effective leader of volunteers must be sensitive to the unique traits of their teams. The leader must appreciate what matters to the volunteer, help her or him find a vision that she or he shares with the team, define her or his role clearly, and help her or him connect to the team and its objective.

For example, every colleague with whom I worked to organize the various Teaching Effectiveness Colloquia had volunteered to work on this initiative (and several have actually paid for their own expenses to travel to the sites of these events). Special consideration must be given to the motivations of these volunteers; the only benefit they will receive from team membership is psychic (development of friendships and potential collaborative relationships, altruism, etc.).

The process outlined in the introduction to section “[Leadership and Consideration of Cultures, Education Levels, and Volunteerism](#)” of this chapter is again of paramount importance when working with volunteers, but when planning the program the most important of these are the factors listed under organization and communication. This once again places the leader in the first quadrant of Fig. 3. However, when dealing with the logistics of these events, I have to recognize that I am the only person on the team who has experience organizing these events, but I must also rely on some teammates who have knowledge of the local culture and available facilities. Thus I want my team members to be engaged, understand, and contribute to the vision, but the event needs only one or two team members to be responsible for the logistics, and that leads me to the fourth quadrant of Fig. 3.

Again, agility and flexibility in leadership style are critical to the success of these events. This is certainly also true for *EORMS* and *INFORMS Transactions on Education* (Fig. 6).

## **Lessons from Icons of Leadership**

We are fortunate to have had many great leaders throughout our history, and we are even more fortunate that many of these leaders committed their principles to words.

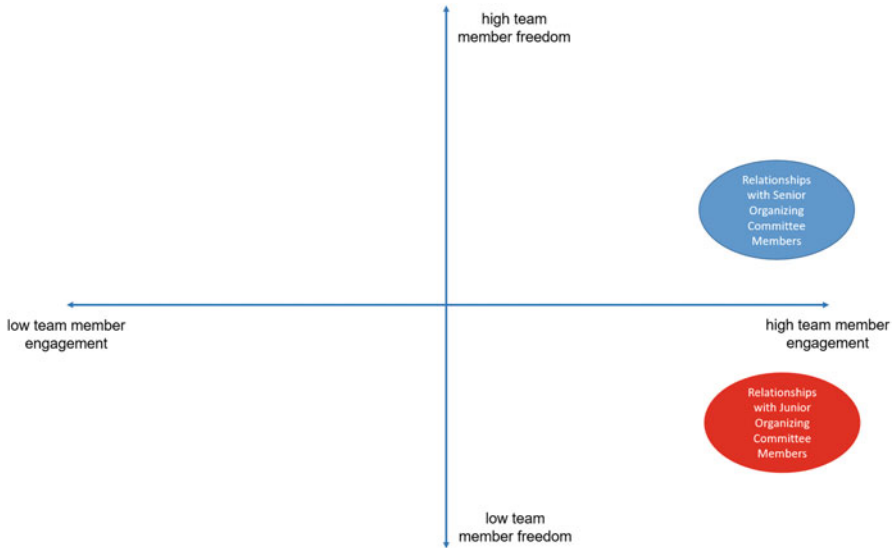


Fig. 6 Teaching Effectiveness Colloquia and the leadership space

In this section, we review the lessons of two leaders I greatly admire and whose wisdom is relevant to the discussion of this chapter.

### ***Dwight David Eisenhower***

Dwight David Eisenhower was a five-star general in the United States Army. As Supreme Commander of the Allied Expeditionary Force in Europe during World War II, he was responsible for planning and supervising the critical invasions of North Africa (Operation Torch) and Normandy (Operation Overlord). After World War II, he succeeded Harry S Truman as the 34th president of the United States. President Eisenhower was, in my opinion, one of the greatest leaders in history, and a person from whom we can learn a great deal about leadership.

Bret Baier, author of *Three Days in January: Dwight Eisenhower’s Final Mission*, succinctly summarized President Eisenhower’s leadership principles in the following manner (Baier, 2017):

1. Be gentle in manner, strong in deed

As a general, Eisenhower stated in reference to his more volatile contemporaries, “You don’t lead by beating people over the head; that’s assault, not leadership.” He clearly demonstrated, through his words and his deeds, that he believed people react more positively to positive messages.

2. Be a navigator, not an instigator

Eisenhower often stated, “Leadership is the art of getting someone else to do something you want done because he wants to do it.” He understood the importance of planning and anticipating, of using carefully selected words to help team members understand their roles and how they will contribute to the team’s mission, and sincerity in motivating others to contribute to a team.

3. Know what you don’t know

Eisenhower understood how much a leader can shake the confidence of her or his team by attempting to disguise her or his lack of knowledge about some aspect of the team’s mission or masquerade as an expert in some critically important area. As has been true of many great leaders throughout history, he appreciated the importance of developing and relying on a trustworthy team of intelligent, talented, and knowledgeable people.

4. Don’t let it go to your head

Eisenhower felt that an effective leader was even-tempered, did not rest on her or his laurels, and learned from but did not dwell on her or his failures. What was most important to Eisenhower as a leader was his team’s achievement of its objective and his team’s fulfillment of its potential.

5. Take the long view

Eisenhower knew that important objectives were generally achieved over a long period. He consistently considered the long view and big picture (i.e., losing the battle but winning the war), and he worked hard with each of his teams to maintain its long view/big picture focus. The bipartisan creation of the Interstate Highway System during his presidency is a prime example of Eisenhower’s long view/big picture focus.

6. Never attack people personally

Eisenhower eschewed criticizing people personally, and he consistently and sincerely looked to understand those who disagreed with him. He once shared this insight with an aide: “A man will respect you and perhaps even like you if you differ with him on issues and on principles. But if you ever challenge his motives, he will never forgive you. Nor should he.”

7. Be the chief morale booster

Eisenhower appreciated the importance of providing inspiration to the members of his team. Perhaps as important, he appreciated the importance of deriving inspiration from the members of his team—and letting the members of his team know how they inspired him.

Adherence to each of these seven principles is important for leaders, but to me the most important lesson President Eisenhower teaches us about effective leadership was expressed by him when he said: “Leadership consists of nothing but taking responsibility for everything that goes wrong and giving your subordinates credit for everything that goes well.” (Goodreads, 2020).

## *Nelson Rolihlahla Mandela*

Nelson Rolihlahla Mandela was a South African anti-apartheid revolutionary, political leader, and philanthropist who was a leader in anti-colonial and African nationalist politics. He was repeatedly arrested for seditious activities, and in 1962 he was sentenced to life imprisonment for conspiring to overthrow the state. After serving 27 years in prison, Mandela was released in 1990 by President F.W. de Klerk, who then worked with Mandela to negotiate an end to apartheid. In an improbable turn of events that still cannot be described as anything less than inconceivable, Mandela and de Klerk were jointly awarded the 1993 Nobel Peace Prize for their efforts, and in the 1994 general election Mandela became South Africa's president. President Mandela formed a multiracial broad coalition government that focused on poverty and economic opportunity, advocated reconciliation between the South Africa's racial groups, and created the Truth and Reconciliation Commission to investigate human rights abuses that occurred under apartheid.

Kevin and Jackie Freiberg, authors of *Madiba Leadership: 5 Lessons Nelson Mandela Taught the World About Change*, succinctly summarized President Mandela's leadership principles in the following manner (Freiberg & Freiberg, 2018):

### 1. Passion Produces Perseverance

How does one emerge from 27 years of incarceration to become his nation's first black president, and then advocate for reconciliation? By caring deeply and intensely, as did Mandela, about the cause for which one is fighting, Mandela understood that such fervor is infectious, and if a leader has and shares her or his deep passion it will permeate her or his team. And this shared passion will help everyone on the team overcome difficult obstacles and challenges.

### 2. Expect Change to be Messy

Often major changes must be made to the current environment in order for a team to achieve its objectives. Some team members or others may resist, and this resistance will create problems. Mandela knew that an effective leader must often convince members of her or his team to accept major changes and, if possible, embrace major changes as opportunities.

### 3. Forgiveness is Key to Focusing Forward

Upon his release after being jailed for 27 years by South Africa's apartheid regime, Mandela would have been justified in being angry, resentful, and bitter. But he realized that this would have made him a prisoner of a different sort. When asked by President Bill Clinton about an apparent flash of anger that television cameras caught on Mandela's face as he was leaving Victor Verster Prison, Mandela responded, "I'm surprised that you saw that, and I regret that the cameras caught my anger. Yes, you are right. When I was in prison the son of a guard started a Bible study and I attended. That day when I stepped out of prison and looked at the people observing, a flush of anger hit me with the thought that they had robbed me of 27 years. Then the Spirit of Jesus said to me, 'Nelson, while you were in prison you were free, now that you are free don't become a prisoner.'" (Campolo, 2000; Myre, 2013).

Mandela recognized that lingering anger and hate interferes with one's ability to interact freely with others, which in turn inhibits one from being a fully effective leader. Instead of reacting as most of us would to his long incarceration, he worked to establish South Africa's Truth and Reconciliation Commission, which is credited with helping South Africa peacefully and compassionately move away from its apartheid past.

#### 4. End Right vs. Being Right

Mandela knew the importance of choosing to end right rather than focusing on being right. In other words, it is more important to find a good resolution to a dispute or disagreement than it is to emphasize who is right or who is wrong. Leaders focus on a positive resolution so the team can move forward and avoid creating or allowing the creation of sides.

"You mustn't compromise your principles, but you mustn't humiliate the opposition," Mandela said. "No one is more dangerous than one who is humiliated." (Quotefancy.com, 2020).

#### 5. Change Begins from the Inside-Out

Mandela understood that all change starts from within; if a leader wants to bring about a change, she or he must first accept and embrace the change herself or himself. And he understood that doing this requires a high level of self-awareness and understanding. In order for Mandela to lead his nation out of the systemic racial discrimination of apartheid and into a peaceful democracy in which all could participate, he would have to *be the change*. He would have to believe in this change so fervently, even in the face of seemingly insurmountable odds, that he would become the embodiment of the change he was seeking.

Adherence to each of these five principles is important for leaders, but to me the most important lesson President Mandela teaches us about effective leadership was expressed by him when he said, "A good head and a good heart are always a formidable combination." (DaumInc, 2017).

## Conclusions

My experiences lead me to the following summary of somewhat interrelated steps I suggest that individuals follow when they find themselves leading multicultural teams of highly educated individuals:

#### 1. Develop a high level of self-awareness and understanding of

- Your personality and temperament
- Your strengths and weaknesses
- Your biases
- Your personal definition of leadership
- The style(s) of leadership that best suit you

Be brutally honest with yourself and ask others you trust for their input.

## 2. Cultivate an understanding of the culture of each of your team members

- Social/interpersonal
- Economic/commerce
- Government/legal
- Linguistic
- Educational

Appreciate the implications on the freedom and engagement the team members will be comfortable with and desire, and use this understanding when assigning tasks to team members.

## 3. Acquire an understanding of the personality and background of each of your team members, appreciate the implications on the freedom and engagement the team members will be comfortable with and desire, and use this understanding when assigning tasks to team members

## 4. Earn and foster each team member's trust in you

## 5. Deal with friction and conflict

- Anticipate friction and conflict and ward it off if possible and advisable (some friction and conflict will be productive and should be allowed)
- Confront friction and conflict immediately, directly, and transparently when they occur
- Use friction and conflict as learning opportunities and as tools to build a stronger team when possible

## 6. Nurture your team

- Share information with them early and freely when possible
- Actively listen to their thoughts and concerns
- Provide them with meaningful responses and feedback

## 7. Embrace the challenges

- Enjoy working with your team
- Let them know that you appreciate their efforts and input
- Let them know you enjoy working with them

## 8. Consider the lessons of Presidents Eisenhower and Mandela from section [“Lessons from Icons of Leadership”](#)

Finally, continuously keep in mind (or remind yourself regularly) that leading a team of highly educated volunteers from a wide variety of cultures is generally challenging, but it is also often the best path to developing an initiative, resolving a problem, or responding to a crisis. When done successfully, it is also extremely gratifying for the leader and the team; in addition to what they can accomplish, these teams can provide everyone involved with tremendous opportunities for professional and personal growth.



## References

- Baier, B. (2017). *Seven business leadership lessons from Dwight Eisenhower*. Forbes Leadership Forum. Retrieved January 31, 2017, from <https://www.forbes.com/sites/forbesleadershipforum/2017/01/31/seven-business-leadership-lessons-from-dwight-eisenhower/#f099043b1888>.
- Campolo, T. (2000). *Let me tell you a story: Life lessons from unexpected places and unlikely people*. Nashville, TN: Thomas Nelson.
- Cochran, J. J. (2011). The making of EORMS. *ORMS-Today*, 38(1). Retrieved from <https://www.informs.org/ORMS-Today/Public-Articles/February-Volume-38-Number-1/The-Making-of-EORMS>.
- Cochran, J. J. (2009). Pedagogy in operations research: Where has the discipline been, where is it now, and where should it go? *ORiON*, 25(2), 161–184.
- Cochran, J. J. (2012). You want them to remember? Then make it memorable! Means for enhancing operations research education. *European Journal of Operational Research*, 219(3), 659–670.
- Cochran, J. J., Cox Jr., L. A., Keskinocak, P., Kharoufeh, J. P., & Smith, J. C. (Eds.). (2011). *Wiley encyclopedia of operations research and management science*. New York: Wiley.
- DaumInc, Kevin (2017). *Quotes on how to be a great leader from Nelson Mandela, Inc*. Retrieved July 19, 2017, from <https://www.inc.com/kevin-daum/31-quotes-on-how-to-be-a-great-leader-from-nelson-.html>.
- Freiberg, K., & Freiberg, J. (2018). *Madiba leadership: 5 lessons Nelson Mandela taught the world about change*. Forbes Leadership Forum. Retrieved July 19, 2018, from <https://www.forbes.com/sites/kevinandjackiefreiberg/2018/07/19/madiba-leadership-5-lessons-nelson-mandela-taught-the-world-about-change/#4910878b41ba>.
- Goodreads. (2020). Retrieved from <https://www.goodreads.com/quotes/815997-leadership-consists-of-nothing-but-taking-responsibility-for-everything-that>.
- Kogut, B., & Singh, H. (1988). The effect of National Culture on the choice of entry mode. *Journal of International Business Studies*, 19(3), 411–432.
- Myre, G. (2013). *The day Nelson Mandela walked out of prison*. National Public Radio. Retrieved June 27, 2013, from <https://www.npr.org/sections/parallels/2013/06/11/190671704/the-day-nelson-mandela-walked-out-of-prison>.
- Quotefancy.com. (2020). Retrieved from <https://quotefancy.com/quote/874425/Nelson-Mandela-You-mustn-t-compromise-your-principles-but-you-mustn-t-humiliate-the>.
- Rossman, A., & Cochran, J. J. (2018). Interview with James J. Cochran. *Journal of Statistics Education*, 26(2), 149–159.

# **Part III**

## **Connecting with Teams**

# Empathy, Humor and Other Emotional Skills in Leadership



Sandra Sebre, Ieva Stokenberga, and Sanita Šaitere

**Abstract** Aspects of emotional and social intelligence, such as self-awareness, self-management, empathy, and social skills, are encouraged for persons in positions of leadership. Empathy, in turn, is a predictor of an appreciation of human diversity. One's sense of humor is advantageous in facilitating effective social communication and positive social interactions.

Daniel Goleman, author of *Social intelligence: The new science of human relationships* (2006), makes special note of his Harvard University statistics professor Robert Rosenthal, who in parallel to teaching statistics was conducting research on rapport, an important aspect of interpersonal communication (Tickle-Degan & Rosenthal, 1990). Social intelligence and emotional intelligence are constructs which largely have become familiar and popular as the result of Goleman's extensive research and reporting on these crucial issues, and particularly well known is Goleman's initial bestseller *Emotional intelligence: Why it can matter more than IQ* (1995), whereby Goleman described how individuals with high emotional intelligence often outperformed those with only a high IQ. Strong evidence linking emotional intelligence specifically to the success of leaders was presented in *Primal Leadership* (Goleman, Boyatzis, & McKee, 2002). The authors explain that primal leadership refers to the emotional dimension of leadership, whereby the leader is capable of articulating a message that resonates with her or his follower's emotional reality and sense of purpose, in order to move others in a positive direction.

Richard E. Boyatzis, expert in the field of [emotional intelligence](#) and professor of Organizational Behavior, Psychology, and Cognitive Science at [Case Western Reserve University](#), emphasizes that the leader's utilization of emotional intelligence is essential in that it affects the awareness of her or his emotions and

---

S. Sebre (✉) · I. Stokenberga · S. Šaitere

Faculty of Education, Psychology and Art, Department of Psychology, University of Latvia, Riga, Latvia

e-mail: [sebre@lu.lv](mailto:sebre@lu.lv); [beatricesebre@gmail.com](mailto:beatricesebre@gmail.com); [ieva.stokenberga@lu.lv](mailto:ieva.stokenberga@lu.lv); [sanita.saitere@lu.lv](mailto:sanita.saitere@lu.lv)

emotional self-regulation, which, in turn, is critical for the effect of the leader's mood on her or his followers (Boyatzis, 2018).

Emotional intelligence is now often cited in managerial and leadership contexts, for example, in the *Harvard Business Review* and *Forbes* business magazine. Aspects of emotional and social intelligence, such as self-awareness, self-management, empathy, and social skills are encouraged for physicians in positions of leadership, as recently noted by the Harvard Medical School medical director Ted James (2019).

An important aspect of both emotional intelligence and social intelligence is the ability to understand another's thoughts and feelings, forming the underpinnings of empathy, which, in turn, is a salient predictor of an appreciation of human diversity—as will be discussed later in this chapter.

Initial acknowledgment of the meaningfulness of emotional and social intelligence can be traced back to ancient Greece. In *The Republic* Plato wrote about the necessity of a holistic educational curriculum, including training in character and moral judgment. In the *Nicomachean Ethics* Aristotle spoke of “practical wisdom” and pointed to the necessity for effective individuals to have a correct understanding of goals, deliberation, and judgment with regard to oneself and others. Aristotle also noted the necessity of being able to empathize and develop positive social relationships in order to be a virtuous, successful person (Zautra, Zautra, Rivers, & Rivers, 2012). In the previous century the construct of social intelligence was firmly advocated by Columbia University psychology professor Edward Thorndike, who in 1920 responded to the then-recent burst of enthusiasm about cognitive IQ testing with a formulation of “social intelligence” as “the ability to understand and manage men and women” (Thorndike, 1920, p. 228).

Emotional intelligence and social intelligence are undeniably related constructs, and they map fairly well onto Howard Gardner's proposed constructs of *intrapersonal* and *interpersonal* intelligence. In his 1983 book *Frames of Mind: The Theory of Multiple Intelligences* Gardner outlined eight intelligences: linguistic, logical-mathematical, musical, spatial, bodily/kinesthetic, interpersonal, intrapersonal, and naturalistic, emphasizing that a person possesses more than merely the linguistic and logical-mathematical intelligence typically assessed by traditional IQ tests. In short, intrapersonal intelligence refers to that which happens as one turns to one's self—one's ability to understand and regulate one's own emotions. In tandem with intrapersonal intelligence, interpersonal intelligence refers to that which happens between oneself and another—the ability to interact effectively, the establishing of rapport, making friends and other important aspects of social interaction.

Peter Salovey, professor of psychology and currently president of Yale University, and John Mayer, professor of psychology at University of New Hampshire, have developed the contemporary leading model of emotional intelligence, as well as the Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT). They define emotional intelligence as a type of social intelligence that involves the ability to monitor one's own and others' emotions, to discriminate among them, and to use the information to guide one's thinking and actions (Salovey & Mayer, 1990). The MSCEIT provides the opportunity to assess four specific aspects

of emotional intelligence. The first includes perceiving emotions—the ability to perceive emotions in oneself and others. The second includes communicating and utilizing emotions—the ability to communicate feelings or to employ them in other cognitive processes. The third involves an understanding of emotions—the ability to understand how emotions combine and progress through the dynamics of relationships. The fourth involves emotion regulation—the ability to be open to feelings, and to modulate them in oneself so as to promote personal understanding and growth (Mayer, Salovey, & Caruso, 2002).

Alex J. Zautra, professor of psychology at Arizona State University, together with colleagues (2012), has provided a conceptual model of social intelligence with implications for management and leadership. Zautra acknowledges the overlap which exists between social intelligence, emotional intelligence, and practical intelligence. However, it is possible to differentiate social intelligence as being focused on an awareness of relevant social situational contexts, the ability to deal with social challenges effectively, the ability to understand the thoughts and feelings of others (cognitive empathy), and the ability to employ social skills in order to maintain positive relationships with others. Zautra also emphasizes that although social intelligence is grounded in genetic predispositions and developmental factors such as the early parent-child relationship, various aspects of social intelligence can be trained and that, in fact, aspects of social intelligence, such as empathy, tend to increase with age.

An important component of Zautra's model of social intelligence is the role of executive functioning—the neurologically based supervisory system which plays a fundamental role in inhibitory control, goal-oriented behavior, strategic planning, and organizational skills. An employee or supervisor with well-developed executive functioning is able to control his or her automatic behavioral responses, has cognitive flexibility which facilitates adaptation to new circumstances, is goal-oriented, and is able to strategically plan what works well and what does not. Contemporary studies show that executive functioning processes are supported by a complex network of connected brain regions encompassing both the prefrontal cortex and parietal lobes (Nowrangi, Lyketsos, Rao, & Munro, 2014). Although studies indicate that executive functioning abilities have significant genetic heritability, nevertheless, these functions develop upon the basis of gene and environment interaction, which allows for the possibility of improvement in executive functioning abilities (Friedman et al., 2016).

Although individuals vary in their level of executive functioning, it is possible to further develop one's social intelligence based upon a training of social skills and an enhancement of values which can facilitate greater social intelligence (Zautra et al., 2012). Among the values which promote social intelligence are humanistic values, recognizing the value and agency of human beings—the thoughts, feelings, hopes, and dreams of other people. A prerequisite for an appreciation of the thoughts and feelings of another is the basic, universal human ability to understand what others are thinking—also referred to as “theory of mind.” This ability develops up to a rudimentary level in most children during the preschool years (Wellman, 2012). However, for children, adolescents, or adults with autism spectrum disorder, the

ability to perceive the thoughts and feelings of others develops much more slowly, or, in some cases, not at all (Baron-Cohen, 2009).

On a philosophical level social connections with others become an essential aspect of human existence within the transcendental theoretical presupposition that “self” cannot be defined apart from “others.” The mutuality and reciprocity inherent in the transcendental worldview is presented by Liu and Robertson (2011) as the highest stage of socioemotional maturation that involves the full realization of the self as interconnected with others. This level of transcendental self-identity is characterized by self-expansiveness that transcends the boundary demarcating the self from non-self, and denotes a sense of interconnection with all living things.

At the neurological level people are “wired to connect” in that there are dynamic, fluid interconnections throughout the brain that guide the development of relationships with others. Goleman writes that “The social brain represents the only biological system in our bodies that continually attunes us to, and in turn becomes influenced by, the internal state of people we’re with. All other biological systems, from our lymphatic glands to our spleen, mainly regulate their activity in response to signals emerging within our body, not beyond our skin” (Goleman, 2006, p. 11). Just as any type of life experience alters the number and strength of neural synaptic connections in the brain, so also social interaction plays a role in reshaping the brain through these processes of “neuroplasticity,” whereby experience affects and alters the biological underpinnings of behavior.

Another important neurological finding which has specific implications for social intelligence and for leadership is the discovery in 1992 of “mirror neurons”—neurons in our brain which “fire” in the same manner if we are engaged in some activity or we are observing another person engaged in this activity (Di Pellegrino, Fadiga, Fogassi, Gallese, & Rizzolatti, 1992). The discovery of mirror neurons happened by accident, as neuroscientists in Giacomo Rizzolatti’s laboratory were studying with implanted electrodes the sensorimotor area of monkeys’ brains and mapping which neurons were firing as the monkey engaged in certain activities. The discovery happened when a research assistant came into the laboratory eating an ice-cream cone, and the sensorimotor cells of the monkey who was watching the assistant became activated in the same configuration as when monkeys themselves are bringing something to their lips. Since this revolutionary discovery in 1992 multitudes of studies have examined and shown a similar functioning of mirror neurons in humans (e.g. Gallese, Keysers, & Rizzolatti, 2004; Iacoboni, 2009).

The discovery of mirror neurons provides a neurological basis for the assumption that “emotions are contagious” (Goleman, 2006). Since the discovery of mirror neurons numerous functional MRI studies have replicated and supported these results, showing that for a person watching a video of someone smiling or scowling, the same brain areas will be activated as if they themselves were smiling or scowling. Therefore, when we watch the emotional expressions of other people, we generally (if there are no neurological disorders) can literally “feel” what the other person is feeling. Watching another person allows us to at least partially experience what the other person is experiencing. Goleman writes: “As mirror neurons bridge brains, they create a tacit duet that opens the way for subtle but

powerful transactions” (2006, p.43). Furthermore, neural imaging studies have also shown that mirror neurons respond to another’s *intentions* to move, and thereby help us to predict what will be happening next (Nakahara, Hayashi, Konishi, & Miyashita, 2002). In regard to leadership, the presence of mirror neurons and the contention that “emotions are contagious” underscore the need for effective leaders to model the kind of emotional expression they would like to see in their subordinates.

## **The Role of Empathy and Tolerance in Leadership and Organizations**

In an article published in the *Journal of Business Ethics* Pavlovich and Krahnke (2012) suggest that empathy is both an intellectual and an emotional response, forming a socioemotional “glue” that connects people, and that the human capacity for connectedness and empathy can be at the core of successful organizations. Themselves creating a connected endeavor, Pavlovich teaching at the University of Waikato Management School in New Zealand, and Krahnke at the University of Northern Colorado, the authors propose that at present there is a paradigm shift in organizational research from the individual to the collective, from an emphasis on competition to a focus on high-quality relationships. This aligns with a general shift in psychology toward an emphasis on positive relationships in contrast to previous emphasis on psychopathology (Seligman & Csikszentmihalyi, 2000). Empathy is brought to the forefront as an important contributor in strengthening social interaction through an ability to motivate individuals to cooperate and engage in pro-social behavior.

Empathy is often defined as the sensing and sharing of feelings of one person by another, albeit with a distinction between “affective empathy,” the sharing of another person’s emotional state, and “cognitive empathy,” the ability to take the perspective of the other person—to understand how the other person is feeling (Lamm, Batson, & Decety, 2007). Empathy can be considered as a necessary prerequisite for compassion, which goes beyond empathy in that it entails action, such as providing emotional support, with the goal of alleviating the suffering of the other person. On a neurological level the ability to empathize with another person has been linked to the functioning of the mirror neuron system and, in fact, mirror neurons have actually been referred to as “empathy neurons” (Oberman & Ramachandran, 2007). Marco Iacoboni (2009), neuroscientist at the University of California at Los Angeles, asserts that “mirror neurons embody the interdependence of ourselves and others,” and serve to connect people in mutual dependency.

Yet in light of the contemporary widespread acknowledgment in the field of psychology that behavior is the result of gene and environment interaction, one must consider not only the neurological underpinnings of empathy, but the importance of development, beginning with early child-parent interaction and attachment behaviors. Multiple dimensions of parenting, such as warmth, responsiveness and

sensitivity, positive reciprocity, empathic caregiving, effective emotion regulation, and specific socialization techniques have been proposed as effective instruments for promoting empathy and pro-social development (Kim & Kochanska, 2017).

Attachment researchers propose that a secure attachment provides fertile ground and a secure base for the emergence of the child's care orientation, empathy, compassion, and pro-sociality (Shaver, Mikulincer, Gross, Stern, & Cassidy, 2016). In response to consistently sensitive and appropriately responsive caregiving, the child develops a sense of secure attachment, and a positive internal working model of the caregiver and self in relationship. Similarly, consistently sensitive caregiving and the parent's ability to help regulate the infant's emotions serve as the basis for effective emotion regulation as the child develops. The parent's own empathy also serves as a model for the child's future empathic responses. The results from two recent longitudinal studies showed that attachment security in the early mother-child relationship was associated with the child's empathic reactions (Kim & Kochanska, 2017). Many studies have shown that the early formed mental representations of self and other are relevant to social-relational behavior across the life span; nevertheless, recent longitudinal studies have pointed to the possibilities for change in emotional, empathic, and social behavior through the adult years (Chopik, Edelstein, & Grimm, 2019).

Recently empathy researchers have proposed a new construct "empathic contagion," which in essence is similar to "emotional contagion," but it allows for the possibility of experiencing the feelings which a person thinks the other might be feeling—even when one is not able to see the other person (i.e. if communicating by e-mail). Researchers of "empathic contagion" have found that this is a heterogeneous construct with differences between "enjoyable contagion" and "aversive contagion" (Murphy, Costello, & Lilienfeld, 2018). Study participants who reported higher ratings of "enjoyable contagion" (e.g. "If I see a video of a baby smiling, I find myself smiling") were more likely to report engagement in sympathetic caring, interpersonal attachment, and experience of psychological well-being. In contrast, higher ratings of "aversive contagion" (e.g. "If I see someone fidgeting, I'll start feeling anxious too") were correlated with emotional distress and features of personality disorder.

At the organizational level, empathy enables people to more easily comprehend and accept human differences, thereby creating more humanitarian, interactive and creative environments (Pavlovich & Krahnke, 2012). In regard to leadership the ability to re-orient toward the suffering of others is a central characteristic of a transformational leader (Parameshwar, 2006), the kind of leader who strives to encourage, inspire, and motivate employees through trust in their ability to take authority over decisions in their professional work. Empathy enhances interconnections and facilitates the organization or community to become more holistic. Leaders who foster empathy and positivity in the workplace facilitate more innovation, creativity, and greater commitment toward their work. Organizational specialists define a positive workplace as one where all employees are valued and supported irrespective of gender, sexual orientation, or color. A positive culture in the workplace is essential for fostering a sense of pride and ownership among the



employees. Subsequently, when people take pride in the organization, they work harder to create opportunities that will benefit the organization (Agarwal, 2019).

Empathic concern, an individual's capacity to emotionally feel warmth, sympathy, and concern for others, has been empirically found to be a salient predictor of tolerance to human diversity. Tolerance has been conceptualized as acceptance and appreciation of those who are different, and is grounded in theories of morality and pro-social behavior, linking tolerance with respect, equality, and acceptance of the coexistence of differing claims of beliefs, values, and ideas, as long as they fit within schemes of pro-social norms and moral values (Hoffman, 2000).

Research has shown that tolerance is not a single global construct, but is context-dependent and multidimensional. This implies that people are neither simply globally tolerant nor intolerant, but rather that people are selective about what they will tolerate, and in which circumstances. In the study by Butrus and Witenberg (2013), they differentiated between the holding of intolerant beliefs, speaking about them, and acting on them. Their research examined the relationships between tolerance, empathy, and personality traits, with results of their research showing that the personality traits of openness and agreeableness were predictors of tolerance, but that empathic concern, the affective component of dispositional empathy, was a more powerful predictor of tolerance than the examined personality traits of openness and agreeableness.

Training programs designed to increase multicultural competence often include a component of empathy training, in addition to training in cultural self-awareness and culturally focused skills in working with people from various cultural groups. In a recent review of cultural competence training outcome studies Benuto, Casas, and O'Donohue (2018) found that the multicultural competence training program instructors who were more open and receptive themselves were able to produce more favorable results in the multicultural competence of their trainees. Similarly, it could be argued that persons in positions of leadership who are more open and receptive to difference will engender a more tolerant organizational climate.

Abernethy and Eriksson (2019) emphasize that it is important for persons in positions of power, such as the therapist in a therapeutic relationship, to acknowledge their own cultural context and identity, which is by nature often fluid and complex. Analogous might be the leader-subordinate relationship in which it would be important for the leader to have increased awareness of their own cultural context and identity, and to model their own ability to be empathetic and tolerant, in order to facilitate a multiculturally tolerant organizational climate.

## **Importance of Humor in Leadership**

In some of his more recent writings Goleman cites the importance of humor in organizational contexts—"good humor signals an emotionally intelligent workplace" (Goleman, 2018). Goleman goes on to emphasize that laughter has been shown to relieve stress, boost engagement and well-being, as well as to encourage creativity, collaboration, and productivity.

An interest in the role of humor within organizations has risen sharply during the past several years, with the publication of several meaningful scientific texts, such as *The Psychology of Humor at Work* (Robert, 2017), and *Humor at Work in Teams, Leadership, Negotiations, Learning and Health* (Scheel & Gockel, 2017), as well as various meta-analyses and review articles. Within these texts the role of the leader's sense of humor and the leader's style of humor are particularly accentuated as a very important and useful personality trait or set of skills that enable the individual to recognize and use humor as a coping mechanism, and to facilitate effective social communication and positive social interactions.

Yet, of note is that humor research customarily draws distinctions between positive and negative humor styles (Martin, Puhlik-Doris, Larsen, Gray, & Weir, 2003). The positive or adaptive humor styles include affiliative humor, which is used to strengthen interpersonal relationships, and self-enhancing humor, which involves a humorous attitude toward stressful events and adversity in life, as a coping strategy in order to manage one's emotions and to reduce stress. Negative humor involves aggressive humor, such as the use of sarcasm to demean others, and self-defeating humor, which uses self-deprecating strategies in order to entertain others.

In a fairly recent meta-analysis Mesmer-Magnus, Glew, and Viswesvaran (2012) analyzed a series of 49 studies, including more than 8500 research participants, and found associations between a supervisor's use of a positive humor style and enhanced workers' job performance, job satisfaction, perception of the supervisor's performance, satisfaction with the supervisor, workgroup cohesion, and reduced work withdrawal. The findings of this meta-analysis were specifically in regard to the use of a positive humor style (Martin et al., 2003), which is characterized by the use of humor for benevolent purposes, such as group inclusiveness and group cohesion, as well as for purposes of encouragement and the overcoming of difficulties. In contrast to a positive humor style, a negative or aggressive humor style in leadership is associated with opposite effects. A leader's aggressive humor style has been associated with weaker identification with the organization, non-productive job performance, less openness of workers in expressing their ideas and opinions, as well as a sense of job insecurity and distrustfulness of the leadership (Karakowsky, Podolsky, & Elangovan, 2019; Liu, Chow, Gong, & Huang, 2019).

Nevertheless, although there is mounting evidence regarding the positive effects of positive humor within the workplace and in relation to employees' job performance, there is reason for caution regarding an unauthentic use of humor by leadership. In fact, research has shown that if the organization's employees perceive the leader's humor as being somehow fabricated or unauthentic, then this could have a reverse, negative effect on the employees' reactions (Michel, Tews, & Allen, 2019). In order for the use of humor to be effective within the organization, it must be spontaneous and playful—therefore, attempts at “humorous interventions” could backfire, if considered as insincere. The associations which have been found between the leader's use of positive humor and employee satisfaction should be used more as a heuristic to explore and evaluate different types of leadership characteristics which are favorable or unfavorable in advancing positive organizational climate.

The way in which a leader's humor is perceived and interpreted by the subordinate is very much dependent upon the leader-subordinate relationship, according to results from a study by Robert, Dunne, and Iun (2015). The authors argue that leader-subordinate relationship quality is an essential, key contextual variable that moderates the relationship between leadership humor and job satisfaction. In a positive leader-subordinate relationship each member of the dyad can calibrate their behaviors and responses to one another. Such synchronicity could be especially likely if both leader and subordinate are high in emotional intelligence or self-monitoring, and thus more likely to be tuned in to the reactions of the other person—i.e. knowing when to stop if the other person may be offended (Robert & Wilbanks, 2012). The results of Robert's study indicate that if the leader-subordinate relationship is already on a negative note, then it may be that either positive or negative (affiliative or aggressive) humor by the leader will be perceived and interpreted as unwelcome, and thereby have an overall negative effect.

The leadership's positive humor will have a greater effect upon the subordinate's positive emotions at work and positive work engagement in situations when the supervisor is employing a transformational leadership style (Goswami, Nair, Beehr, & Grossenbacher, 2016). The transformational leadership style means that the leader strives to encourage, inspire, and motivate employees through trust in the employees' ability to take authority over decisions in their assigned jobs. This type of leadership style is designed to encourage and facilitate employee creativity and the ability to seek new solutions to old problems. With such a transformational leadership style, in combination with the use of positive humor by the organizations' leadership, there is likely to be a greater sense of positive emotions among the employees, which then will affect work engagement and work productivity.

Humor is an essential aspect of the overall organizational climate. A greater sense of importance attributed to the use of positive humor by the organization's leadership is associated with greater job satisfaction and organizational commitment. On the other hand, the use of negative humor engenders an opposite effect (Cann, Watson, & Bridgewater, 2014).

But as in life more generally, these associations between humor and leadership are not always so straightforward and simple—there is often a certain degree of complexity. In a recent study in the United Kingdom Evans and Steptoe-Warren (2018) requested employees to evaluate their managers' expressions of humor as well as their work environment. These researchers found that a combination of different humor styles can be meaningful, and with the assistance of cluster analysis they identified three humor style profiles. The first cluster of "positive" humor included an above-average use of positive humor styles, and below-average use of negative humor styles. The second cluster was referred to as "aggressive" managers and included a diminished use of all types of humor except aggressive humor. The third cluster was referred to as the "humor endorsers" and included above-average use of all humor styles. The employees with "aggressive" managers reported higher levels of stress, lower job satisfaction, lower rates of communication at work, and less perceived support for creative endeavors. They rated their manager as having lower leadership power, as being weaker leaders. However, the employees

who rated their managers as “humor endorsers” rated the work environment and job satisfaction as similar to that of employees who rated their managers as demonstrating primarily “positive” humor.

This leads one to believe that if a leader uses exclusively aggressive humor, this will result in a negative impact on the organizational climate. However, if the leader is comfortable with the use of various humor styles, this allows for engagement with the various benefits of using humor—to facilitate a sense of belonging, to lessen stress, to enhance interpersonal communication, to create a less serious and more spontaneous atmosphere—even though at times the leader’s humor may seem somewhat deprecating or inappropriate.

The results from this research foster an awareness of the differences in organizational climate and differences in how employees perceive and interpret their leadership’s use of humor—what is considered as funny, and what not. These interpretations, in turn, are further associated with the organization’s existing social norms and unwritten rules of social conduct. There are organizations in which the employees, including the managers, give allowance or preference to such expressions of humor which in another context would be considered as unacceptable, but they can be accepted and perceived as beneficial if balanced with expressions of positive humor.

In summary, one may conclude that a leader whose personality allows her or him to use humor in an authentic, free, and spontaneous manner can gain benefits from this in their professional work environment. Humor has the potential to increase positive affect, to strengthen community bonds, to decrease feelings of stress, and to facilitate a playful and creative atmosphere. Of note, however, is that joking can help to distract one from various difficulties (and sometimes this is necessary), but humor cannot be a replacement for problem resolution strategies. Cheerfulness can help to unite people, but too much joking can also create divisiveness—so a leader must always keep in mind that it is important to laugh together with one’s subordinates, rather than to laugh at them. Joking can be harmful at times, and the disclaimer that it was “only a joke” can, unfortunately, also serve to encourage prejudice and the normalization of discrimination (Ford, Richardson, & Petit, 2015).

A leader’s witticisms can seriously affect not only the organizational climate, but also the level of acceptability of certain forms of behavior. It is especially important for a leader to have cognizance of any form of abuse or bullying, and to not allow this not only in one’s own behavior, but also in the behavior of one’s subordinates. Before jabbing at someone with a caustic note, it is always important to consider the intent of this joke, and whether it will have a beneficial effect. One of the most essential aspects that differentiates friendly joking around from ridicule, mocking, and verbal aggression, or that differentiates satire from sarcasm is the notion of moral goodness (Ruch, Heintz, Platt, Wagner, & Proyer, 2018)—do I really hope and believe that my humor will have a positive outcome. A friendly, playful joke about the shortcomings of a job performance could help the employee to see their own mistakes, and it could become a learning experience that she or he can smile about, rather than resulting in diminished feelings of self-worth. It is a challenge for an effective leader to be aware of one’s own emotions so as not to hide them

beneath the guise of humor—otherwise it is possible to fall into the trap of using humor to “soften” one’s anger or feelings of hostility. An emotionally intelligent way of responding to one’s own anger would involve self-reflection and awareness of one’s own feelings, as well as the ability to manage one’s emotions without doing harm to another.

In order to benefit one’s own mental health it is advisable for leaders to consider the use of humor, and to recognize the benefits of taking a somewhat lighter approach to the smaller and greater challenges which life brings. In a recent meta-analytic review, “‘A joke a day keeps the doctor away?’ Meta-analytical evidence of differential associations of habitual humor styles with mental health” (Schneider, Voracek, & Tran, 2018), the authors concluded that positive humor styles were overall positively correlated with better mental health. The largest positive correlations were observed between self-enhancing humor (taking a humorous stance toward life’s adversities) and optimism.

The authors suggest that the use of self-enhancing humor as an emotion regulation strategy could be particularly beneficial to overall mental health. Affiliative humor was to a large extent associated with self-esteem in this meta-analysis. Several studies have found affiliative humor to be positively associated with extraversion (Plessen et al., 2020), thereby also linking affiliative humor to a cluster of personality traits. Taking into consideration that leaders by definition are often confronted with stressful life situations, it may be useful for leaders to strengthen their ability to look at situations from a more humorous perspective, thereby making themselves feel better, making the situation feel less ominous, and enhancing one’s ability to look for new problem resolutions. The leader’s use of positive humor can serve as a behavioral role model for the entire team, and can also demonstrate that the leader encounters difficult moments, but that they can be dealt with more readily with the use of humor.

## **Concluding Remarks and Suggestions for Mastering Emotional Skills**

The extent of a leader’s social skills in managing relationships and resolving conflict to move people in a desired direction, as well as the leader’s emotional self-awareness and emotional self-regulation, has been shown to be an essential aspect of leader effectiveness, and these aspects of emotional intelligence are critical for the effect of the leader’s mood on her or his followers (Boyatzis, 2018). However, this does not mean that leaders need to be invariably positive and looking only “on the bright side of life.” Although the benefits of positive emotions in relation to job performance and career success are well documented (e.g. Lyubomirsky, King, & Diener, 2005; Walsh, Boehm, & Lyubomirsky, 2018), there is also evidence that negative emotions can be of benefit in certain work situations.

A new concept in emotion research is “emodiversity” (Quoidbach et al., 2014), which refers to the variety and relative abundance of different emotions that humans experience. The study by Quoidbach et al. (2014) showed that emodiversity, whether positive or negative, was associated with better mental and physical health across two large cross-sectional studies. The authors suggest that experiencing many different emotional states may have more adaptive value than experiencing fewer states—similarly as biodiversity increases resilience to negative events. Whereas experiencing only sadness may lead to social withdrawal, a combination of sadness and anger could impel the individual to seek some form of problem resolution. Grossmann, Oakes, and Santos (2019) found that a rich and balanced emotional life can facilitate “wise reasoning” about a given situation, because emodiversity can provide valuable information about the features of a situation and allow for more informed predictions of future actions.

After evaluating the evidence it is reasonable to want to reap the beneficial outcomes of emotional intelligence. The good news is that there are evidence-based methods both to assess and to develop emotional intelligence. For example, Paloma Cantero-Gomez (2019), an expert on leadership and entrepreneurship, suggests the following eight steps in advancing emotional awareness and emotional intelligence: (1) identifying and labeling one’s feelings; (2) assessing the intensity and duration of feelings; (3) expressing feelings; (4) controlling emotional impulses; (5) delaying gratification; (6) reducing stress; (7) knowing the difference between feelings and actions; and (8) using one’s emotions at the right time and in the right way. As statisticians become more aware of their roles as leaders they should promote within themselves and their colleagues personal growth in social and emotional awareness, in order to further promote appreciation of inclusiveness and diversity.

In summary, it may be a good idea to follow the wise words of Yoda: “Use your feelings, Obi-Wan, and find him you will” (McCallum & Lucas, 2005, as cited in Grossmann et al., 2019).

## **Action Plan Strategic Components**

- It is recommended for persons in positions of leadership to continue their personal growth in practicing an awareness of their own emotional diversity, as well as in practicing an attitude of care toward themselves and others.
- It is recommended to use self-directed benevolent humor to address one’s own imperfections or difficulties in dealing with certain situations. Taking a less serious, more playful approach can signal to team members that mistakes and adversity are a normal part of life, and that an acceptance of life’s challenges is to be valued and embraced.
- It is important to express zero tolerance for aggressive or cynical jokes that could potentially be made at the expense of others.
- It is important to recognize the positive effects of diversity within a team—to celebrate diversity, as it makes life more rich and colorful.

- It is important to remember that “emotions are contagious” and that empathy can be contagious as well in stimulating an inclusive and diversity-rich environment.

## References

- Abernethy, A. D., & Eriksson, C. B. (2019). The power of relationships for bridging difference. *Training and Education in Professional Psychology*. Advance online publication. <https://doi.org/10.1037/tep0000292>.
- Agarwal, P. (2019). *How to create a positive workplace culture*. Retrieved December 5, 2019, from <https://www.forbes.com/sites/pragyaagarwaleurope/2018/08/29/how-to-create-a-positive-work-place-culture/#54ad2bb4427>.
- Baron-Cohen, S. (2009). Autism: The Empathizing–Systemizing (E-S) theory. *Annals of the New York Academy of Sciences*, 1156, 68–80.
- Benuto, L. T., Casas, J., & O’Donohue, W. T. (2018). Training culturally competent psychologists: A systematic review of the training outcome literature. *Training and Education in Professional Psychology*, 12, 125–127.
- Boyatzis, R. E. (2018). The behavioral level of emotional intelligence and its measurement. *Frontiers in Psychology*, 9, 1438.
- Butrus, N., & Witenberg, R. T. (2013). Some personality predictors of tolerance to human diversity: The roles of openness, agreeableness, and empathy. *Australian Psychologist*, 48(4), 290–298.
- Cann, A., Watson, A. J., & Bridgewater, E. A. (2014). Assessing humor at work: The humor climate questionnaire. *Humor: International Journal of Humor Research*, 27(2), 307–323.
- Cantero-Gomez, P. (2019). *Emotional intelligence: The 8 evolutionary steps to master emotional skills*. Retrieved December 2, 2019, from <https://www.forbes.com/sites/palomacanterogomez/2019/05/21/emotional-intelligence-the-8-evolutionary-steps-to-master-emotional-skills/#168f9dab6190>.
- Chopik, W. J., Edelstein, R. S., & Grimm, K. J. (2019). Longitudinal changes in attachment orientation over a 59-year period. *Journal of Personality and Social Psychology*, 116(4), 598–611.
- Di Pellegrino, G., Fadiga, L., Fogassi, L., Gallese, V., & Rizzolatti, G. (1992). Understanding motor events: A neurophysiological study. *Experimental Brain Research*, 91(1), 176–180.
- Evans, T. R., & Steptoe-Warren, G. (2018). Humor style clusters: Exploring managerial humor. *International Journal of Business Communication*, 55(4), 443–454.
- Ford, T., Richardson, K., & Petit, W. (2015). Disparagement humor and prejudice: Contemporary theory and research. *Humor*, 28(2), 171–186. <https://doi.org/10.1515/humor-2015-0017>
- Friedman, N. P., Miyake, A., Altamirano, L. J., Corley, R. P., Young, S. E., Rhea, S. A., et al. (2016). Stability and change in executive function abilities from late adolescence to early adulthood: A longitudinal twin study. *Developmental Psychology*, 52(2), 326–340.
- Gallese, V., Keysers, C., & Rizzolatti, G. (2004). A unifying view of the basis of social cognition. *Trends in Cognitive Sciences*, 8(9), 396–403.
- Goleman, D. (1995). *Emotional intelligence: Why it can matter more than IQ*. New York: Bantam Books.
- Goleman, D. (2006). *Social intelligence: Beyond IQ, beyond emotional intelligence*. London: Hutchinson.
- Goleman, D. (2018). *Don’t laugh. Humor can boost the bottom line*. Retrieved December 2, 2019, from <https://www.kornferry.com/institute/humor-emotional-intelligence-leadership>.
- Goleman, D., Boyatzis, D., & McKee, A. (2002). *Primal leadership: Realizing the power of emotional intelligence*. Cambridge, MA: Harvard Business Review Press.



- Goswami, A., Nair, P., Beehr, T., & Grossenbacher, M. (2016). The relationship of leaders' humor and employees' work engagement mediated by positive emotions. *Leadership & Organization Development Journal*, 37(8), 1083–1099.
- Grossmann, I., Oakes, H., & Santos, H. C. (2019). Wise reasoning benefits from emodiversity, irrespective of emotional intensity. *Journal of Experimental Psychology: General*, 148(5), 805–823.
- Hoffman, M. L. (2000). *Empathy and moral development: Implications for caring and justice*. New York: Cambridge University Press.
- Iacoboni, M. (2009). *Mirroring people: The science of empathy and how we connect with others*. New York: Picador.
- James, T. A. (2019). *Emotional intelligence for physician leaders*. Lean Forward Harvard Medical School CME Online. Retrieved November 1, 2019, from <https://leanforward.hms.harvard.edu/2019/06/13/emotional-intelligence-for-physician-leaders/>.
- Karakowsky, L., Podolsky, M., & Elangovan, A. R. (2019). Signaling trustworthiness: The effect of leader humor on feedback-seeking behavior. *The Journal of Social Psychology*. <https://doi.org/10.1080/00224545.2019.1620161>
- Kim, S., & Kochanska, G. (2017). Relational antecedents and social implications of the emotion of empathy: Evidence from three studies. *Emotion*, 17(6), 981–992.
- Lamm, C., Batson, C. D., & Decety, J. (2007). The neural substrate of human empathy: Effects of perspective taking and cognitive appraisal. *Journal of Cognitive Neuroscience*, 19(1), 42–58.
- Liu, C. H., & Robertson, P. J. (2011). Spirituality in the workplace: Theory and measurement. *Journal of Management Inquiry*, 20(1), 35–50.
- Liu, F., Chow, I. H. S., Gong, Y., & Huang, M. (2019). Affiliative and aggressive humor in leadership and their effects on employee voice: A serial mediation model. *Review of Managerial Science*. <https://doi.org/10.1007/s11846-019-00334-7>
- Lyubomirsky, S., King, L., & Diener, E. (2005). The benefits of frequent positive affect: Does happiness lead to success? *Psychological Bulletin*, 131(6), 803–855.
- Martin, R. A., Puhlik-Doris, P., Larsen, G., Gray, J., & Weir, K. (2003). Individual differences in uses of humor and their relation to psychological well-being: Development of the Humor Styles Questionnaire. *Journal of Research in Personality*, 37(1), 48–75.
- Mayer, J. D., Salovey, P., & Caruso, D. R. (2002). *Mayer-Salovey-Caruso emotional intelligence test*. Toronto, ON: Multi-Health Systems, Inc.
- Mesmer-Magnus, J., Glew, D. J., & Viswesvaran, C. (2012). A meta-analysis of positive humor in the workplace. *Journal of Managerial Psychology*, 27(2), 155–190.
- Michel, J. W., Tews, M. J., & Allen, D. G. (2019). Fun in the workplace: A review and expanded theoretical perspective. *Human Resource Management Review*, 29(1), 98–110.
- Murphy, B. A., Costello, T. H., & Lilienfeld, S. O. (2018). Is empathic contagion helpful or harmful? Overlooked heterogeneity in the empathy index. *Psychological Assessment*, 30(12), 1703–1708.
- Nakahara, K., Hayashi, T., Konishi, S., & Miyashita, Y. (2002). Functional MRI of macaque monkeys performing a cognitive set-shifting task. *Science*, 295(5559), 1532–1536.
- Nowrangi, M. A., Lyketsos, C., Rao, V., & Munro, C. A. (2014). Systematic review of neuroimaging correlates of executive functioning: Converging evidence from different clinical populations. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 26(2), 114–125.
- Oberman, L., & Ramachandran, V. (2007). The simulating social mind: The role of the mirror neuron system and simulation in the social and communicative deficits of autism spectrum disorders. *Psychological Bulletin*, 133(2), 310–327.
- Parameshwar, S. (2006). Inventing higher purpose through suffering: The transformation of the transformational leader. *The Leadership Quarterly*, 17, 454–474.
- Pavlovich, K., & Krahnke, K. (2012). Empathy, connectedness and organisation. *Journal of Business Ethics*, 105, 131–137.
- Plessen, C. Y., Franken, F. R., Ster, C., Schmid, R. R., Wolfmayr, C., Mayer, A., et al. (2020). Humor styles and personality: A systematic review and meta-analysis on the relations between



- humor styles and the Big Five personality traits. *Personality and Individual Differences*, 154, 109676. <https://doi.org/10.1016/j.paid.2019.109676>
- Quoidbach, J., Gruber, J., Mikolajczak, M., Kogan, A., Kotsou, I., & Norton, M. I. (2014). Emodiversity and the emotional ecosystem. *Journal of Experimental Psychology: General*, 143(6), 2057–2066.
- Robert, C. (Ed.). (2017). *The psychology of humor at work*. New York: Routledge.
- Robert, C., Dunne, T. C., & Iun, J. (2016). The impact of leader humor on subordinate job satisfaction the crucial role of leader-subordinate relationship quality. *Group & Organization Management*, 41, 375–406.
- Robert, C., & Wilbanks, J. E. (2012). The wheel model of humor: Humor events and affect in organizations. *Human Relations*, 65, 1071–1099.
- Ruch, W., Heintz, S., Platt, T., Wagner, L., & Proyer, R. T. (2018). Broadening humor: Comic styles differentially tap into temperament, character, and ability. *Frontiers in Psychology*, 9, 6. <https://doi.org/10.3389/fpsyg.2018.00006>
- Salovey, P., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition, and Personality*, 9, 185–211.
- Scheel, T., & Gockel, C. (2017). *Humor at work in teams, leadership, negotiations, learning and health*. New York: Springer.
- Schneider, M., Voracek, M., & Tran, U. S. (2018). “A joke a day keeps the doctor away?” Meta-analytical evidence of differential associations of habitual humor styles with mental health. *Scandinavian Journal of Psychology*, 59(3), 289–300.
- Seligman, M., & Csikszentmihalyi, M. (2000). Positive psychology. *American Psychologist*, 55, 5–14.
- Shaver, P. R., Mikulincer, M., Gross, J. T., Stern, J. A., & Cassidy, J. (2016). A lifespan perspective on attachment and care for others. In J. Cassidy & P. R. Shaver (Eds.), *Handbook of attachment: Theory, research and clinical applications* (3rd ed., pp. 878–916). New York: Guilford Press.
- Thorndike, E. (1920). Intelligence and its use. *Harper's Magazine*, 140, 227–235.
- Tickle-Degnen, L., & Rosenthal, R. (1990). The nature of rapport and its nonverbal correlates. *Psychological Inquiry*, 1(4), 285–293.
- Walsh, L. C., Boehm, J. K., & Lyubomirsky, S. (2018). Does happiness promote career success? Revisiting the evidence. *Journal of Career Assessment*, 26(2), 199–219.
- Wellman, H. M. (2012). Theory of mind: Better methods, clearer findings, more development. *European Journal of Developmental Psychology*, 9(3), 313–330.
- Zautra, A. J., Zautra, E. K., Rivers, C., & Rivers, D. (2012). Foundations of social intelligence: A conceptual model with implications for business performance. *Current Topics in Management*, 16, 15–37.

# Personal and Collective Development Via Conversational Intelligence



Adriana Pérez

*True humility is not thinking less of yourself; it is thinking of yourself less.*

C.S. Lewis

**Abstract** This chapter focuses on emotional intelligence, levels of emotional intelligence, needed skills to develop conversational intelligence, and how to use these skills in the field of statistics. The chapter encourages the reader to invest your time in developing emotional and conversational intelligence as tools for leadership in your own career.

## Introduction

Emotional intelligence is one of the most demanded skills in the world (Forum, 2016). Professionals in the field of statistics require balancing statistical, social, and collaboration skills. The purpose of this chapter is to encourage the reader to invest their time in developing emotional and conversational intelligence as tools for leadership, in addition to statistics skills. This chapter explains what these skills are, what the interconnected components of these skills are, how to develop them, and how they will turn into individual and collective leadership in our beloved field of statistics. I share my own experiences with the readers as examples of how my mentors imparted responsibilities, traditions, practices, and knowledge to me on these skills. My hope is that these examples motivate the reader to pass the torch to others.

---

A. Pérez (✉)

Department of Biostatistics and Data Science, School of Public Health, The University of Texas Health Science Center at Houston, Austin Campus, Austin, TX, USA  
e-mail: [Adriana.Perez@uth.tmc.edu](mailto:Adriana.Perez@uth.tmc.edu)

## Emotional Intelligence

On January 23, 2017, I was introduced to the terms “emotional” (Salovey & Mayer, 1990) and “conversational intelligence” during the Executive Leadership Institute (Program Administration Team, 2017) hosted by my institution, the University of Texas Health Science Center at Houston (UTHealth). While pursuing my undergraduate degree in statistics, I realized I was a leader by organizing study groups with my peers and being a female minority in my profession. In the spring of 1986, there were 28 freshmen in our first semester pursuing a bachelor’s degree in statistics at the National University of Colombia. Only seven of these 28 students were eligible to continue into the second semester, as the other 21 failed all courses in the first semester and were dismissed from the statistics program and the university in general. Among these seven, only three of us successfully passed all the courses during this first semester; I was the only woman of these three. During my student orientation, I recalled that the National University of Colombia introduced us to their scholarship program. This scholarship program promised a full-ride master’s program to the first three students in their graduation cohort in the institution. I decided to try to get one of those three spots. My two male friends and I worked hard during the 5 years of our bachelor’s degree in statistics, and I won the first place for that competitive scholarship. I was the first to graduate as I completed my undergraduate thesis 6 months ahead of my peers. I fell in love with biostatistics during the fourth year of my bachelor’s program when I took the course Experimental Design, taught by statistician Pedro Nel Pacheco. We had a field trip to the National Center of Coffee Research (Centro Nacional de Investigaciones de Café-Cenicafé) in the city of Chinchiná, Colombia (National Federation of Coffee Growers, 2019). At Cenicafé (National Federation of Coffee Growers, 2019), we saw first-hand many plot designs seeking to determine the best fertilizers, the best worms to help the coffee plants, the best plantain trees around the coffee trees, the differences in varieties and flavors of coffee trees in Colombia and many other outcomes. I was disappointed when I learned there was not a single biostatistics degree program in Colombia and I had to apply for a master’s or doctoral degree overseas. I started my master’s degree in the fall of 1992 and I completed both my master’s and doctoral degrees at Tulane University in November 1995.

I did not realize I was learning about my emotional and conversational intelligence since I entered college, both by working collaboratively with others, and, even more importantly, by observing and following the examples of the excellent mentors I had throughout my studies and work. I never took a course on leadership until January 2017 and its terms were completely new to me.

Statisticians and biostatisticians receive a lot of training in mathematics, calculus, and all series of statistics-related courses, and possibly some electives in public health, environmental sciences, psychology, sociology, economics, and epidemiology. Courses on how to manage our emotions are generally not included in the professional curriculum. Depending on your family background, one may or may not have schooling about your emotions. Coleman describes the biology

of the healthy and unhealthy connections, as well as the description on the amygdala hijack: our amygdala is an emotional sentinel, able to commandeer our brain (Coleman, 2005). When the amygdala hijacks our brain, our emotions can overwhelm our thinking, causing us to think and act irrationally. Without accurately perceiving situations, we cannot find the right words, our nature responds with actions of “fight or flight”: we feel anxious, fear, sweat, twitch, clench the jaw, tap our foot, nervous, etc. Emotional intelligence in our brain allows for a more fitting and corrective response. We will start by defining emotional intelligence, including identifying the skills involved, how to conduct conversational intelligence, and the leadership competencies that can increase satisfaction and vital culture in our organizations.

### ***Definition of Emotional Intelligence***

Mayer and Salovey (1997) defined emotional intelligence as “the ability to perceive emotions, to access and generate emotions to assist thought, to understand emotions and emotional knowledge, and to reflectively regulate emotions to promote emotional and intellectual growth.” Coleman (2005) defined it as “understanding one’s own feelings, empathy for the feelings of others and the regulation of emotion in a way that enhances living.” Coleman (2005) indicated that emotional intelligence is more important than our intelligence quotient. Some of the reasons for us to develop our emotional intelligence in our profession are: (1) deadlines and external requirements to meet, (2) competing priorities, (3) communication challenges, (4) diversity of professionals, cultures, and backgrounds, (5) conflicts at work, (6) differences in people’s demographics, (7) different strategies to manage stress levels as well as (8) different expectations when changes happen. Therefore, we as statisticians should maintain a balanced emotional repertoire in addition to our statistical expertise, as both are integral parts of our leadership skills (Golbeck, Olkin, & Gel, 2016).

### ***Skills to Develop Emotional Intelligence***

Developing emotional intelligence entails increasing our (1) self-awareness, (2) self-management, (3) social awareness and social skills, and (4) adaptability (American Management Association, 2017; Coleman, 2005).

#### **Self-Awareness**

Self-awareness is our ability to identify our own emotions and the impact our emotions and reactions play in any situation (Program Administration Team, 2017).

Self-knowing and straightforwardness are skills that help us understand our own emotions (Coleman, 2005). Both seeking to know ourselves and to identify our emotions, help us to develop this skill.

### **Self-Management**

Self-management is the ability to manage your own emotions in the midst of strong negative emotions within or in your environment (Program Administration Team, 2017). Self-management requires increasing our self-control, our self-confidence, and our self-reliance (Coleman, 2005). This skill requires self-talk seeking ways to handle fears, anxieties, anger, and sadness (Coleman, 2005), and adapting emotions, our mood, reactions, and responses. This ability implies that we monitor and assess our own emotions and make adjustments accordingly (American Management Association, 2017).

### **Social Awareness and Social Skills**

Social awareness is the ability to accurately perceive and understand the emotional states of others. Social skills is the ability to utilize awareness of other's emotions to build relationships, teams, and support networks. We seek to develop the ability to connect and the ability to perceive and understand the emotions of the people around us. When we discern people's feelings, we can develop our understating of their emotions (empathy); with that understanding, we will be able to relate to people more effectively. When we relate to people more effectively, we build relationships, we can negotiate or achieve healthy conflict, and we will be able to work as team-players more effectively (American Management Association, 2017).

### **Adaptability**

Adaptability is the ability to maintain equilibrium despite variances and changes that occur both internally and externally in one's life. It requires optimism and self-actualization (Program Administration Team, 2017). Other resources called for are motivation (Program Administration Team, 2017) and achievement (American Management Association, 2017). We seek to develop the ability to direct our emotions in a positive and productive way. When our emotions are balanced, we can adapt without difficulty, we motivate ourselves and motivate others, we take appropriate action, we commit, we follow through, and we work toward the achievement of our goals. Others will see us as constructive members of our teams (American Management Association, 2017).

Providing one example of my personal development in these skills may help bring these concepts home. In academia, around 10–12 weeks before each semester starts, faculty members check their course schedules before students can register for

courses for the next semester. One particular semester, my boss's wife informed me that I had to change my proposed date and time for my course because she had to offer her new course in my previous day and time slot. At that time, our program sought to avoid having two courses running simultaneously as the program was beginning. My colleague played the "boss's-wife" card as the rationale for me to modify my course days and times. With the card she played, my distrust was high. I learned something from my colleague that I did not know before, and it was a hard lesson to digest. The relationship of my thoughts, feelings and reactions were spirals towards a fight. If my colleague provided other motivations besides being my boss's wife for her request, I did not hear them. I did not have the skills to take new information. However, I agreed to change the day and time of my course offering (adaptability). At the end of the day, walking out of the office, I started crying, I was upset (self-awareness). My emotions were in a rollercoaster; what was behind being upset? (self-awareness). I was sad that she did not use her faculty rank to request the change but she used the boss's-wife card to request the change (empathy). I started my self-talk. Did I listen to any other reasons for this requested change (self-management?) Would this change help our students or only her (social skills)? I knew she was two faculty ranks above me (self-awareness) and I was not sure what future consequences I would face if I did not comply with her request (self-management). I was in a weak position (self-management). I did not connect with my colleague (zero social awareness). I kept my focus on the student's perspective that they could register for both courses if they needed to (adaptability).

During my institutional training, we were provided the website link, given as a reference, for each of us individually to determine our own emotional intelligence (Institute for Health and Human Potential, 2019). It is a free test at the time of writing this chapter.

## **Conversational Intelligence**

Conversational intelligence has been defined as the ability to connect, to navigate and to grow with others (Program Administration Team, 2017). Conversational intelligence is the key to success in life and in our profession. Conversational intelligence is not about how smart we are, but is about how open we are to learning new and effective conversational rituals that send signals to the brain for trust, partnership, and mutual success. Trust is the feeling of confidence and security that the other person cares (i.e., I am safe and I know you have my back). On the other hand, distrust is the feeling of being unsafe. Distrust is associated with intense emotions, such as apprehension, fear, and terror. These feelings immediately signal to our amygdala or primitive brain to defend ourselves. In order to build trust, we need to have conversations to overcome distrust.

## ***Levels of Conversation***

There are three levels of conversation (Glaser, 2014). The first level is known as a transactional conversation. This level focuses on telling and asking, an exchange of information as well as stating updates and facts between the parties (i.e., it feels good). This first level is commonly used in transitional working relationships. The second level is known as the positional conversation. In this second level, the parties advocate and inquire details of the topic of conversation. Each party advocates for what they want instead of telling the other party what to do. Each party may also inquire what the other party's beliefs are and how those beliefs may influence their thinking process. This second level of conversation involves a conditional trust (i.e., defend what you believe). The third level of conversation is known as the transformational conversation. In this level of conversation, both parties share information, and those conversations usually help participants discover aspects unknown by either one or both parties. In this third level of conversation, the trust is open and helps to create greater shared success. This is the level of conversation where discovery happens and both parties discern aspects that are new to each other. Being aware of and using these designations of conversation levels can help us evaluate our own levels of conversation and provide guidance to navigate and develop a plan to reach the level of needed with each team member or person in our department/institution to build trust.

## ***Skills to Build Trust***

As leaders in our field, we need to develop conversations in order to connect and communicate with our teams. We need to create a positive shift with team members that shifts the brain chemistry toward trust. To do this, five skills can be practiced within team meetings: (1) each team member can start with asking discovery questions that help to reveal the needs of the team members (i.e., place of birth, favorite food, hobbies, etc.); (2) listening actively to other team members and practicing understanding the types of listening skills that each team member has (i.e., repeat or paraphrase what the person understood); (3) members can dramatize the message to obtain in-depth information about the needs of each member of the team (i.e., drawing, exaggerating the voice when emphasis is wanted, etc.); (4) team members can reinforce success from month-to-month activities among others (i.e., birthdays, new babies, new publications, moving to a new place, awards, etc.); (5) combining these four activities will allow team members to build rapport and to build the trust.

Leaders should prioritize trust within teams. This involves: (1) the equivalent of shaking hands (see <https://www.cnn.com/travel/article/handshake-alternatives-gestures-around-world-trnd/index.html>), which allows the neurochemical raising of trust levels, and removes uncertainty; and/or (2) shifting the outcome of meetings

by starting with quick trust building activities that can take 5 min. For this one please create rules of engagement to answer a question in writing to build trust (i.e., Do you prefer to drink coffee, tea, or water?). Then each team member has 30 s to write their answer, 30 s to share their answer to other team members and another 30 s to ask for comments regarding the trust-building activity. These types of trust-building activities generate feelings in each of the members that from the amygdala's perspective will feel satisfied and there is no need for the amygdala to act as a protector. In addition, our emotional needs are also being taking care of because emotions can be shared safely.

My institution received funding for the creation of the Center for Tobacco Regulatory Science in Youth and Young Adults. There were three large R01 grants running simultaneously, and each R01 grant hired many staff members who were unknown to each other. In addition, three more cores complemented the R01s. One of these cores was the administrative core in charge of building the administration of the center and who took the lead in building trust for all team members. To get to know each other, the administrative core proposed a retreat and asked all members of the center to complete a personality test before the retreat date. During the retreat, the personality tests were revealed and the facilitator explained what each personality type likes and does not like when communicating with the other types of personalities. Next, members of each personality type were grouped in teams to get to know each other and to talk about the accuracy of their preferences in communication. The administration core scheduled monthly meetings with all members of the center and collected and presented a report showing the number of abstracts submitted to conferences, presentations, manuscripts submitted, grants submitted, theses, and dissertations defended and pilot projects awarded. During the course of the grant, there were many opportunities to build trust and team members became more conversationally intelligent with their team members. During the five-year duration of the center grant, there were 84 publications. This number would not have been possible if the administration core would not have facilitated this level of trust on all center members.

### ***Blind Spots***

There are several blind spots to keep in mind when seeking to become conversationally intelligent individually or collectively as part of a team (Glaser, 2014). The first blind spot is to assume that others see what we see, feel what we feel, and think what we think. When we are absorbed and attached to our own points of view, we are unable to connect with others' perspectives. In fact, we have a high addiction to being right when we communicate "our understanding." The second blind spot to consider in professional teams is that feelings of trust, distrust, and fear may fluctuate across time. Therefore, professionals are encouraged to plan on how to realize that there are changes, how to talk about them, how to see and interpret the realities of those changes, etc. For example, there could be external situations that



bring fear to some members of the team but not to all members. We, as leaders, can promote conversations on fears, or trust issues to the overall team after reaching some level of trust with the plans to raise new conversations. The third blind spot is the lack of empathy within the team when we are fearful or upset. It is imperative that our self-management process recognize upsetting moments are not appropriate times to have “empathy” with others. Most probably we will show other feelings but no empathy. Our role as leaders is to develop a strategy to overcome this blind spot. Next, we often assume that we remember what others said, when we actually remember what we think about what others said. Recommendations to reduce this blind spot include making the team aware that it is important to (1) drop out of conversations every 12–18 s to process what people are saying and (2) focus on what we think about what another person is saying, which involves a stronger internal process. The fifth blind spot is the assumption that meaning resides in the speaker, when in fact it resides in the listener (Glaser, 2014).

### *Antidotes for Disconnection and Distrust*

Our blind spots spring from our reality gaps. There are some antidotes for team-member disconnect and distrust. First, because meaning resides in the listener, the speaker needs to take time to validate and link back to make sure both the listener and the speaker have the same picture and shared meaning. Both parties should be expected to communicate to confirm that their team reality and mine are the same or if there are gaps. Second, we need to remind our team that each team member has different experiences. Each team member knows that we are different people, we came from different parts of the world, and we use different languages to label our world. Culture is so important that the cultural experiences even within the same states may play a role in communication and trust within the team. Third, investing in activities to listen creates conversational rituals and practices that harmonize our experiences, create a shared language, and help us bridge and connect with others easily and fully. It creates a shared reality. Fourth, avoid having uncomfortable conversations. Instead, develop the ability to have conversations that are uncomfortable by developing the ability to ask discovery questions in a safe space. Get help from your human resources office on how to develop a plan with crucial conversations. Continually checking and correcting the blind spots allows for building connections and sustaining trust within teams.

On January 1, 2017, I started my three-year term serving as a member for the Committee on Minorities in Statistics, having been appointed by the president of the American Statistical Association the previous year. The committee is responsible for (1) fostering greater participation in statistics by members of under-represented minority groups in the field and (2) encouraging research to develop, evaluate, and implement policies and interventions to improve the condition of minority populations in the United States under the activities of this committee (American Statistical Association, 2019a). One of the activities promoted by this committee

is the Diversity Mentoring Program, which is hosted the first day of the Joint Statistical Meetings (JSM) each year (American Statistical Association, 2019b). The committee included a session about emotional and conversational intelligence in their session on August 1, 2017. After a short presentation, two exercises were conducted between mentees and their paired mentors. The first is known as the Double Clicking Exercise (Glaser, 2013), with the goal that each mentor/mentee pair briefly describe what represents success individually and then discuss the topic collectively and build the relationship between mentee and mentor in this scientific conference. The second activity was the LEARN (Like, Excite, Anxiety, Reward, Need) (Program Administration Team, 2017). Mentees and mentors were asked to answer five questions during this program: What did you like most about this diversity workshop? What excited you most about this diversity workshop? What created the greatest anxiety? What can be celebrated about the way the mentee-mentor meeting opportunities were handled? What are the next steps the mentee and mentor need to take to stay on track for this mentoring program? The mentees and mentors shared with me that they found the exercises to be new and helpful in developing their trust within their respective mentee-mentor pairs.

## **Leadership Competencies with Emotional and Conversational Intelligence**

Whether or not we view ourselves as leaders in statistics or biostatistics, we are expected to grow in our profession. This includes developing our leadership ability and fostering leadership skills for others within our profession and in our own institutions. The American Management Association trains leaders in leading with emotional intelligence (American Management Association, 2017), and they propose six leadership competencies that generate three goals to drive results, increase satisfaction in teams, and create dynamic organizational cultures. These six leadership competencies are: (1) building our own personal influence/credibility with others (including implementing empathy with others and analyzing resistance in others to identify alternative strategies); (2) inspiring others; (3) strategies to strengthen collaboration (including describing collaborations with emotionally intelligent relationships and fostering inquiries for relationships and creativity of the team members); (4) managing changes across time (including strategies to handle the emotions associated with changes and resistance to change); (5) development and management of healthy conflict (including strategies to create and maintain healthy conflict); and (6) team leadership (assessing team performance, team stress/mood levels to remain optimistic/productive and build cultures of healthy conflict resolution practices).

UTHealth is a component of the statewide University of Texas system. The UTHealth School of Public Health (SPH) has six campuses. The main campus is in Houston, and the others are located in Austin, Brownsville, Dallas, El Paso, and

San Antonio. The Department of Biostatistics and Data Science is one of the four departments within SPH. Faculty from different departments are located at each of the six campuses. All six campuses have access to dedicated Interactive Television (ITV) lines for teaching. Faculty members across campuses develop their research meeting activities both locally and across campuses using these ITV connections, and, in recent years, by video conferences via WebEx (Cisco, 2019). Challenges in teaching, research projects, and service across campus can be expected, but the example of fostering communication across the six campuses and within faculty across departments was modeled to me by Dr. Cheryl Perry. The Austin campus started in 2007 under the model of shared team science. Dr. Perry was the Austin Dean from its inception until August 2018. She communicated to all Austin faculty members her vision of seeking to develop the campus and promote all faculty. Dr. Perry encouraged faculty members to think not only of their own promotion and tenure, but also to help other faculty develop for the greater good of the campus. This shared vision was communicated to me when our campus was able to allocate resources to hire a second biostatistician for our campus and I was appointed chair of the faculty search committee for the position. After 8 years serving as Dean of the Austin campus, Dr. Perry won the 2015 UTHealth President's Award for Leadership. I have had the privilege of working with Dr. Perry and learning her leadership skills on how to be a successful leader, fostering leadership with faculty locally and nationally, demonstrating leadership, and passing the torch to others. Without her example, I would not have nominated myself to the role of faculty chair for SPH across the six campuses. I assumed the role of Faculty Elected chair for the entire school in September 2017, then I assumed the role of Faculty Chair for the academic year 2018–2019, and now I am the Past Faculty chair for the academic year 2019–2020. I employed emotional and conversational intelligence skills in order to update and pass the current faculty compensation plan at UTHealth. These skills are also indispensable when facing other highly challenging aspects of day-to-day faculty needs. In May 2019, I was given the honor to serve as Faculty Marshall during the graduation ceremony for my institution in Houston. For these reasons, I would like to encourage you, the reader of this chapter, to develop and practice leadership skills within your own institution.

## Action Plans

- Encouraging the readers to improve our work environments: Each one of us must grow our own emotional intelligence. Each one of us must develop conversations in order to connect and communicate with members in our institutions and continue to be leaders in our fields with emotional intelligence.
- Promoting diversity and inclusion in organizations: Fostering diversity and inclusion involves emotional intelligence conversations across many levels of any organization. In academic settings, Faculty search committees members who incorporate LEARN activities may help to synchronize the entire committee and

to be proactive and successful in the diversification process of our profession. Advocates are encouraged to ask discovery questions when seeking to promote faculty who have not had the same opportunities as their counterparts.

- Passing the torch requires investment of our time and being constantly intentional to train and develop future generations of leaders in our institutions. Sharing and modeling day-by-day leadership and emotional intelligence skills will help to increase the growth of leaders across time that are committed to the mission and vision of their institutions.

**Acknowledgments** Thank you to Drs. Cheryl L. Perry, Deanna M. Hoelscher, Lemuel A. Moyé III, Rodolfo J. Dennis, and Pedro Nel Pacheco for their mentorship.

## References

- American Management Association. (2017). *Leading with emotional intelligence*. Developed by Susan Mason and Donna Dennis.
- American Statistical Association. (2019a). *Committee on minorities in statistics*. Retrieved October 23, 2019, from <https://community.amstat.org/cmismis/home>.
- American Statistical Association. (2019b). *Joint Statistical Meetings 2019*. Retrieved October 23, 2019, from <https://www.amstat.org/ASA/Meetings/Joint-Statistical-Meetings.aspx>.
- Cisco. (2019). *WebEx 2019*. Retrieved October 23, 2019, from <https://www.webex.com/>.
- Coleman, D. (2005). *Emotional Intelligence: Why it can matter more than IQ* (10th Anniversary ed.). New York: Bantam.
- Forum, W. E. (2016). *Executive summary. The future of jobs. Employment, skills and workforce strategy for the fourth industrial revolution*. Retrieved October 27, 2019, from [www3.weforum.org/docs/WEF\\_FOJ\\_Executive\\_Summary\\_Jobs.pdf](http://www3.weforum.org/docs/WEF_FOJ_Executive_Summary_Jobs.pdf).
- Glaser, J. E. (2013). *Sums conversational intelligence. Free book summaries created for church leaders*. Retrieved October 31, 2019.
- Glaser, J. E. (2014). *Conversational intelligence: How great leaders build trust and get extraordinary results*. Brookline, MA: Routledge.
- Golbeck, A. L., Olkin, I., & Gel, Y. R. (2016). *Leadership and women in statistics*. Boca Raton, FL: CRC, Taylor & Francis Group.
- Institute for Health and Human Potential. (2019). *Test your Emotional Intelligence with our Free EQ Quiz*. Retrieved October 29, 2019, from <https://www.ihhp.com/free-eq-quiz/>.
- Mayer, J. D., & Salovey, P. (1997). What is emotional intelligence?: Educational implications. In P. Salovey & D. J. Sluyter (Eds.), *Emotional development and emotional intelligence* (pp. 3–34). New York: Harper Collins.
- National Federation of Coffee Growers. (2019). *National Center of Coffee Research (Centro Nacional de Investigaciones de Café) Cenicafé*. Program of Scientific Research. Retrieved October 20, 2019, from <https://www.cenicafe.org/es/index.php>.
- Program Administration Team. (2017). *The leadership institutes*. Houston, TX: The University of Texas Health Science Center at Houston.
- Salovey, P. M., & Mayer, J. D. (1990). Emotional intelligence. *Imagination, Cognition and Personality*, 9, 185–211.

# The Neuroscience of Human Connection and Leadership



Nicole A. Lazar

**Abstract** Advances in neuroimaging methods have changed the way that psychologists study human behavior and cognition. These techniques are not, however, without statistical pitfalls. This chapter surveys some recent studies on the psychology of social connection and leadership, with a particular emphasis on methodological caveats.

## Introduction and Some Caveats

One of the grand challenges of our time is to understand how the human brain works: how it takes in information and processes it; how it turns thought into action; and how it is affected by age or by disease. As humans, we have always been fascinated by these questions, especially insofar as they reflect on our functioning in the world. As reflective beings, we have explored these questions through history, philosophy, and psychology. What has changed recently is that we have developed technology that may aid us in finding more direct answers, through the study of brain processes themselves.

Over the past several decades, functional neuroimaging techniques, such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), electroencephalography (EEG), and others, have brought new insight into the human brain and how it works. These techniques vary in their biological mechanisms; fMRI, for example, is based on the magnetic properties of blood, whereas EEG exploits electrical signals in the brain. Since fMRI is probably the most widely used imaging method, due in part to its non-invasive nature, the current chapter will focus on that modality. All functional neuroimaging modes, however, have some common characteristics.

---

N. A. Lazar (✉)

Department of Statistics, Pennsylvania State University, University Park, PA, USA

e-mail: [nfl5182@psu.edu](mailto:nfl5182@psu.edu)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_8](https://doi.org/10.1007/978-3-030-60060-0_8)

First, neuroimaging techniques provide indirect measures of brain activation. Direct measurement is possible only through implantation of electrodes into the neurons, which is not generally feasible in a research environment, nor would it be truly practical for studying human cognition and brain function on a grand scale. Second, these studies result in large data sets, even for a single subject; with multiple groups of subjects (e.g., healthy controls and individuals with schizophrenia; or women and men) and multiple subjects per group, functional neuroimaging studies are firmly in the realm of “Big Data.” Third, the data structure tends to be complex, with spatial and temporal correlations that are not entirely understood. The statistical analysis of neuroimaging data poses many challenges and, as a consequence, has been a rich source of methodology development in the realms of statistics, data science, computer science, and engineering.

These advances have not come without controversy, however. As with many areas of science, functional neuroimaging has been prone to some well-publicized failures of a statistical nature, particularly problems of multiple hypothesis testing, reproducibility, and “p-hacking.” For example, a typical fMRI study collects data at hundreds of thousands of volumetric elements, or voxels—the three-dimensional analog of the more familiar pixel. At each voxel, a statistical model may be fit or a hypothesis test carried out, with the goal of “activation detection,” i.e., identifying those voxels that are responsive to a stimulus or involved in performing some cognitive task (which may be as simple as tapping the fingers, or as complex as solving a math problem, all while the subject’s brain is being imaged). With so many simultaneous tests, the potential for false positives when traditional statistical cutoffs (“ $p < 0.05$ ”) are used is immense.

Hence a fair bit of energy has been devoted to the multiple testing problem in neuroimaging studies, or control of Type I error in the presence of hundreds of thousands of tests. Family-wise error, false discovery rate, methods that take account of the spatial structure in the data, and the like have all been proposed, advocated for by statisticians, and implemented in standard software packages or made freely available by researchers. Surprisingly, however, it is still possible to find in the neuroimaging literature published studies that do not make any correction for multiple testing. Here is one place where readers should thus exercise caution: has this issue been addressed, adequately or at all?

Furthermore, in the early 2010s works were published that cast doubt on the reliability and accuracy of one of the most popular software packages for fMRI data analysis, specifically the modules that deal with corrections for multiple testing. The results of thousands of published studies were called into question (Eklund et al. 2012, 2016). Even though further investigation revealed that the problem was not as serious as first suspected, these findings cast a pall over the field.

Reproducibility or replicability of results is of concern in many areas of science. Terminology varies depending to some extent on discipline; the meaning here is whether results from one study, e.g., regarding which areas of the brain are involved in a particular task, are robust or repeatable across studies and experimental groups. A finding that region X differs between, say, men and women, is only interesting if that difference is found in repeated studies; if it is the transient or random finding

in a single study based on a relatively small number of subjects, its believability is questionable. Since neuroimaging data are noisy, indirect measures of actual neuronal activity, many supposed effects are hard to model or identify; one needs to be wary of chasing after noise. The issue is exacerbated by the fact that it is expensive and time consuming to collect neuroimaging data; studies with a small number of subjects, on the order of 20 or 30, are not uncommon even now.

It is also important to note that there is a wide range of possible analysis paths. Again, taking fMRI as an example, the data are preprocessed in various ways before they get to the stage of statistical analysis. The goal of preprocessing is to remove noise coming from the scanner or from the subject, to dampen the effect of outliers, and in general to “clean up” the data prior to more formal statistical analysis. The effects of the common preprocessing steps are not well studied nor well understood; but, see work by Rowe and colleagues for a principled examination (for example, Karaman et al. 2014). Different labs have different standard preprocessing steps, which can be carried out in different orders. Some of the steps also carry within them choices (e.g., tuning parameters of various types). The analysis itself can proceed along different lines. Indeed, by one estimate the number of possible analysis pipelines for a single fMRI study is close to 70,000 (Poldrack et al. 2017). With this large number of “forking paths” (Gelman and Loken 2013), one should not be surprised that studies do not necessarily replicate. And once again the need for caution in reading reports of functional neuroimaging experiments is apparent.

Finally, there is the issue of “reverse inference” or inferring mental function from activation (Poldrack 2011). This is akin to the probabilistic reasoning that leads us to conflate  $P(A|B)$  with  $P(B|A)$ , or to conclude that the  $p$ -value gives the probability of the null hypothesis (given the data) being true. As noted by Poldrack (2011), neuroimaging yields information about the probability of activation given that the mental process was engaged. One cannot simply switch those around to argue for the mental process given activation; the path from one to the other flows through Bayes’ theorem, which in turn requires knowledge about the base rates of activation of regions, and of mental processes. If a region that tends to activate in many different situations activates also in a particular study targeting a particular mental process, one should not perhaps be surprised, nor should one ascribe too much importance to that finding. Such subtle probabilistic arguments are often overlooked in the presentation of results from neuroimaging studies.

With these caveats in mind, the remainder of this chapter takes a critical look at the study of leadership and human connection through the neuroscience lens. It is worth reemphasizing at the outset that one needs to be cautious in interpreting the results of these functional neuroimaging studies; the human brain is remarkably complex and neither the quality of the data nor the quality of the statistical approaches are yet at the point where they can yield definitive answers to questions of interest. While similar statements could be made about many areas of science, it is precisely our fascination with how the brain works that can lead us to put more credence on these results than they perhaps warrant. In addition, social phenomena are subtle and almost certainly affected by a wide range of forces both external

and internal to the individual. How well these can be simulated in the scanning environment, if at all, to provide real insight into social processes, is a question that also must be considered when evaluating such studies.

## Studies of Human Connection

Humans, like other primates, are social animals. This is manifest in behavior and life patterns—organizing into communities and families—and in neuroimaging studies, where there is evidence that we may be “wired” for human connection. In intriguing early research, for example, Eisenberger et al. (2003) demonstrated similarities in brain activation between experiences of physical pain and social pain (in the form of perceived social exclusion). In this study, subjects played a virtual ball tossing game while in the MR scanner, apparently with two other players; in fact, there were no other players, just a computer programmed for simulated play. During one condition, subjects were told that technical difficulties prevented them from joining the game, and hence they were only able to observe. During the second condition, subjects were included in the game, but after several tosses of the ball the other “players” began to exclude the subjects. After the scanning session, subjects received a questionnaire asking about their feelings of exclusion and levels of social distress.

The researchers found that certain regions of the brain associated with alarm, distress, and physical pain were more activated during the “exclusion” condition, during which subjects indeed reported feeling left out. Additionally, the network or pattern of association between those regions was similar in the social exclusion condition to what had been previously found in studies of physical distress (Lieberman and Eisenberger 2008). This is an interesting indication that the brain experiences “social pain” (exclusion from a game in this instance) much like it does actual physical pain. The study however was based on just 13 undergraduate students, a small and selective sample and certainly not one from which wide-sweeping conclusions should be—or can be—drawn. Follow-up studies by the same research group have found similar relationships and effects, which does strengthen the overall claim of a connection between how the brain processes these two types of pain and highlights that humans are intrinsically social.

Minor social “pinches” (Lieberman and Eisenberger 2008), such as unfair treatment, apparently also activate some of the same brain regions. Conversely, fair treatment, altruistic behavior, and other positive social interactions lead to brain responses that are related more generally to reward systems. As noted by Lieberman and Eisenberger (2008): “When our social needs are being satisfied, the brain responds in much the same way as it responds to other rewards that are more tangible” (p. 5).

More recently, the so-called default mode network, which is associated with background thought and daydreaming and is elicited during “resting state” fMRI (i.e., where no task is performed or stimulus presented), has also been shown to



be involved in social thought (Meyer et al. 2019). Specifically, some of the brain regions that are part of the default mode network appear to also be involved in the encoding of social information. This suggests that one role of rest may be to consolidate social cognition and cues, which in turn may facilitate interpersonal interactions. Again, this was a small-scale study, just 19 undergraduate students, hence results should be interpreted with caution. Furthermore, the default mode network presents in a wide variety of situations, invoking the problem of inverse inference and making it harder to attribute a relationship between the network and specific processes or behaviors.

Although this is just a very brief look at the field of “social cognitive neuroscience” (Lieberman and Eisenberger 2008), and with the drawbacks firmly in mind, these studies offer at least some initial indications that we are neurologically inclined to forge connections with other human beings. Patterns of both brain activation and connectivity between brain regions evidently support social interaction and function. Whether these findings would hold up in larger and more general groups of subjects (i.e., beyond undergraduate students) remains to be explored.

## Studies of Leadership

The study of leadership from a neuroscience perspective, the so-called “neuroleadership” or organizational neuroscience, is a subfield of the social cognitive neuroscience discussed in the previous section. The focus here is specifically on organizational behavior and most often, apparently, specifically on leaders. This side of social neuroscience is perhaps not surprisingly more controversial. While some, such as Becker and Cropanzano (2010) and Becker et al. (2011), tout the potential of neuroscience research to advance the understanding of organizational behavior, others, for instance, Lindebaum (2013) and Lindebaum and Zundel (2013), are more skeptical. Unlike the study of social connection, which is—or can be placed at—an ostensibly objective level, the use of neuroscience generally, and neuroimaging more specifically, for the exploration of leadership potentially raises ethical considerations (Lindebaum 2013). There is clearly a distinction to be made between effective and ineffective leaders; however, should a person in position of leadership with a less than optimal brain scan—one that shows him or her to be less effective than others—be penalized? Removed from the position of authority? And how would this even be determined? The mere activation of certain brain regions, say those related to cognitive or emotional control, does not imply that individuals exhibiting these patterns of activation will be better leaders, or will react in a particular way to a stressful situation (Lee et al. 2012). Since the science of attributing traits to specific brain regions is itself far from complete (assuming such an endeavor is feasible or even realistic—the inverse inference problem again), it is hard to make the leap from a scan of any type to management decisions in practice, as the enthusiasts advocate. The constellation of brain, past history, the work environment, and other factors, all have their role in determining our complex behaviors and reactions.

The ethical issue arises most acutely when one crosses from the realm of empirical research to attempts to change behavior on the basis of what, as has already been noted, are findings of uncertain reliability. Lindebaum gives examples of the use of biofeedback to “retrain the brain” of leaders whose brain scans show them to be “deficient” in the activation of some supposedly key area for effective leadership. Not only is such an approach based on questionable research, it arguably infringes on the rights of the individual to lead the organization as he or she sees fit and elides the fact that there are multiple ways to be an effective leader. Furthermore, as also argued by Lindebaum and Zundel (2013) effective leadership involves not just the leader but also those with whom he or she interacts. The leader-centric view does not acknowledge this reality fully. Research from the perspective of the other person in the relationship, the “follower” (as in Boyatzis et al. (2012)), is also inadequate. As convincingly argued by Lindebaum, the group as a whole needs to be considered, since effective leadership is a function of the organization or group, as well as the person in the leadership role. It is therefore not as straightforward to examine these dynamics in a neuroscience context, which by nature is focused on the individual.

Nonetheless, some researchers have made efforts in this direction. If one strips away exaggeration born of enthusiasm, what can be gleaned from these studies? The goal is not an exhaustive accounting, but rather to highlight a few cases in order to understand what this literature has to offer, as well as its pitfalls.

Transformational leadership (see, for example, Bass 1990) is generally considered to be among the most effective leadership styles. Transformational leaders inspire others by their vision for the organization (*inspirational motivation*), and their personal charisma. They model the behaviors and qualities they desire in their teams, serving as an example for those under their leadership (*idealized influence*). In addition, these leaders give individual attention to those in their group, helping them to grow and perform better (*individualized consideration*), at the same time challenging those in the organization to reach a higher level of achievement (*intellectual stimulation*). According to Bass, transformational leaders are respected, trusted, and admired by their followers, which in turns inspires and energizes them.

How do transformational leaders arise? While some people may naturally have the requisite characteristics, clearly not all do. Balthazard et al. (2012) performed an EEG study in an attempt to differentiate transformational from non-transformational leaders. In contrast to other experiments that have been surveyed in this chapter, Balthazard and colleagues started with a large sample of 200 civilian and military leaders. Additionally, they recruited on average four subordinates or peers for each of the 200, who were asked to assess their leadership style using a standard questionnaire, the Multifactor Leadership Questionnaire (MLQ). Finally, the researchers collected resting-state EEG data from the 200 subjects using a 19-channel cap. EEG caps place a series of electrodes on the scalp, through which electrical activity in the brain is measured. The number of channels corresponds to the number of electrodes at which signal is measured; this may vary considerably across studies, though spatial resolution clearly increases with the number of electrodes.

This experiment has several positive features that are worth highlighting, although the study as a whole falls short. First, as already mentioned, the researchers started with a large sample of 200 leaders, both military and civilian, male and female, and at different stages of career. Second, they used a split-sample approach, building their linear discriminant model for distinguishing transformational from non-transformational leaders on half the data set (the “training sample” in machine learning parlance) and testing it on the remainder (the “testing sample”). Third, they elicited multiple assessments on leadership style for each subject.

On the other hand, the EEG was based on just 19 channels, a very small number that reduces the already relatively limited spatial resolution of EEG. Since the study aimed to use patterns of brain activation to distinguish between the two types of leader, diminished spatial resolution of the data is a serious drawback. The EEG data themselves were subjected to an extreme amount of statistical processing in an effort to reduce close to eleven thousand original “features” (or predictor variables) to 58. In addition, both in the training and testing samples only the most extreme subjects on either end of the transformational leadership scale were retained (that is, the most transformational and the least transformational), so that the model was built on just 40 out of the original 100 training set subjects.

With such manipulations of data, differences between those rated high on the transformational leadership quality and those rated low were found, although the discriminant scores of the two groups overlapped to a fair extent. More interesting, and perhaps indicative of the potential of the approach, was the finding that EEG signals from certain brain regions dominated the discriminant function. The reliability of this finding, however, is brought into question by the small number of channels.

Taking a more follower-centric approach, Boyatzis et al. (2012) examined memories of experiences that test subjects had with resonant and dissonant leaders. Resonance refers to a positive interpersonal connection, the feeling of being “in sync” with the other. Dissonance is the opposite of that. According to Boyatzis and colleagues, “[i]nteractions that produce a positive emotional tone and interpersonal synchrony can be considered resonant, whereas those that produce a negative emotional tone and interpersonal difficulty can be considered dissonant” (p. 261). As they note, there is an actual physiological connection to be made as well, since a dissonant relationship with a leader can engage the known “fight or flight” response.

In this fMRI study, subjects in advanced career stages were asked to recall interactions with dissonant and resonant leaders. Notably, to participate in the study each subject had to be able to identify at least two resonant and two dissonant leaders from their working past, and to recall with some level of detail at least two incidents involving each of those four distinct leaders. A very small sample of just eight subjects was recruited. Although the authors described the study as “exploratory,” they carried out formal hypothesis tests along with accompanying *p*-values. Subjects were asked to recall the events in question while in the scanner; there is evidence that thinking about an emotional or physical reaction, such as in memory, at least partially activates the same brain areas as are involved in the action itself. They were also asked questions about how they felt about the leader in question.

In the analysis, the researchers identified regions of the brain that were activated during memories of resonant leaders, regions that were activated during memories of dissonant leaders, and regions that were differentially activated during memories of the two types of interactions. The default mode network, which appeared in the previous section in the context of social thought, was detected here as well. Regions related to “mirror neuron” systems also played a part. Mirror neurons are related to empathy, positive social interaction, and imitation. Again, one should not place too much credence on the results but rather treat them as intriguing directions that may warrant further (confirmatory) analysis.

Becker and Cropanzano (2010) also discussed the potential role of mirror neurons, noting that leaders can set the tone of their organization by modeling behavior, setting the example that they want to see in others. The mirror neuron network could be a conduit by which these behaviors are propagated through the organization, as others would “mimic” (or “mirror”) the behaviors exhibited by the leaders. In such an indirect fashion, they argue, organizational climate can possibly be changed.

The previously cited research on positive social interaction also yields advice for leaders. According to Lieberman and Eisenberger (2008), “This suggests that the exclusive premium put on financial rewards as incentive around the office may be overstated. Being treated with respect and as a valued member of the organization may activate reward systems in the brain that promote stronger learning of behaviors that predict more of these social rewards in the future. And obviously, providing social rewards is an extremely cost effective measure, requiring only a bit of time and thoughtfulness” (p. 5).

The role of neuroscience in management studies is still the topic of ongoing debate. Some (Lee et al. 2012; Ashkanasy et al. 2014; Healey and Hodgkinson 2014) call for a middle ground: while recognizing the dangers of “neuro-euphoria” (Ashkanasy et al. 2014) and exaggerated faddish claims, they nonetheless see a role for neuroscience in enhancing our understanding of different leadership styles. Healey and Hodgkinson describe a conceptual framework in which internal (to the individual) and higher-level processes interact. Exploiting multiple modes of measurement and building an integrated statistical model, rather than relying on neuroscience alone, represents one such middle ground.

## Conclusion

This chapter has attempted to give a brief overview of what the field of neuroimaging currently has to say about our propensity to forge connections with others, and about leadership. While there are certainly intriguing hints and indications, especially regarding the social nature of human beings, it is important to temper enthusiasm with a clear understanding of what we can—and cannot—learn from neuroimaging studies. As is evident from the works surveyed here, there are a variety of statistical difficulties, chief among them the small sample sizes that are characteristic of many

of the experiments. Small samples are not unusual in functional neuroimaging, in part because of the difficulty in recruiting and retaining clinical populations of interest, but this is not (or should not be) a problem in the area of social cognitive neuroscience, which relies on healthy subjects for the most part. A good first step, then, would be to increase sample sizes for confirmatory examinations of the hypotheses generated from the already existing literature.

Other issues are reflective of the state of research in some areas of social psychology more generally, for example, conflation of exploratory and confirmatory studies, and incomplete presentation of statistical results (for instance, *t* tests and *F* tests reported without the accompanying degrees of freedom were rife in the literature surveyed). While these are not disqualifying in and of themselves, they give additional reason for caution before one draws wide-ranging conclusions. Certainly, the leap to “neuroleadership” and the direct application of findings from these studies to individuals in leadership positions, along with the attendant ethical concerns described throughout this chapter, is not at this time warranted.

Of the two main themes in this chapter, social connectivity seems to be the less fraught, falling more squarely into traditional social science research, but using neuroscience tools to elucidate behaviors of interest. And there are intriguing early signs of the reassuring idea that we are inclined to social behavior.

The question of leadership is more controversial. It seems highly unlikely, based on our current state of knowledge, that there would be a brain region for leadership in general, or transformational leadership style more specifically. Similarly, it is doubtful that there is even a brain network dedicated to just that purpose. Current technology can help researchers to identify differences in brain regions and their patterns of activation, as well as in brain networks and their patterns of connectivity for the different types of leaders, under the highly structured and mostly unrealistic setting of the fMRI scanner. What is gained from this? Understanding of one type of human characteristic under experimental conditions in the laboratory, at this point in time. Interesting, quite possibly, but far from a strong brain-based theory of leadership.

If such differences are found, reliably and replicably across groups and in different circumstances, this raises the natural question: What is the next step? Should a business, or a university, or the military require brain scans for anyone being considered for a position of leadership? Should only those who fit the brain scan profile of a transformational leader—assuming such can be isolated—be allowed into leadership roles? Is the same leadership style necessarily best for all organizations and all circumstances? Leadership sometimes calls on the individual to make decisions in a split second (e.g., in the military), and often under pressure. It is surely the accumulation of many of these decisions and behaviors that makes the leader and his or her style.

In spite of the pessimistic tone, one should not forget that social cognitive neuroscience in general is a relatively new field. The application to leadership studies is newer still. Just as neuroimaging techniques have shed light on other brain processes—though not necessarily to the extent that psychologists hoped for or predicted at the outset—they may also yield useful information on these complex, group-oriented interactions.

## Action Items

1. Embrace a transformational style of leadership, which recognizes the unique contributions of all team members and inspires everyone to aim higher.
2. Acknowledge that people bring different backgrounds, experience, and knowledge to an organization; treat this not as a threat but as an opportunity.
3. Strive to create an environment in which members of the organization are comfortable expressing their opinions and views: listen, rather than speak; consult, rather than impose a perspective; and use data to bolster decision-making.

## References

- Ashkanasy, N. M., Becker, W. J., & Waldman, D. A. (2014). Neuroscience and organizational behavior: Avoiding both neuro-euphoria and neuro-phobia. *Journal of Organizational Behavior, 35*, 909–919.
- Balthazard, P. A., Waldman, D. A., Thatcher, R. W., & Hannah, S. T. (2012). Differentiating transformational and non-transformational leaders on the basis of neurological imaging. *The Leadership Quarterly, 23*, 244–258.
- Bass, B. M. (1990). From transactional to transformational leadership: Learning to share the vision. *Organizational Dynamics, 18*, 19–31.
- Becker, W. J., & Copranzano, R. (2010). Organizational neuroscience: The promise and prospects of an emerging discipline. *Journal of Organizational Behavior, 31*, 1055–1059.
- Becker, W. J., Copranzano, R., & Sanfey, A. G. (2011). Organizational neuroscience: Taking organizational theory inside the neural black box. *Journal of Management, 37*, 933–961.
- Boyatzis, R. E., Passarelli, A. M., Koenig, K., Lowe, M., Mathew, B., Stoller, J. K., et al. (2012). Examination of the neural substrates activated in memories of experiences with resonant and dissonant leaders. *The Leadership Quarterly, 23*, 259–272.
- Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science, 302*, 290–292.
- Eklund, A., Andersson, M., Josephson, C., Johannesson, M., & Knutsson, H. (2012). Does parametric fMRI analysis with SPM yield valid results? An empirical study of 1484 rest datasets. *NeuroImage, 61*, 565–578.
- Eklund, A., Nichols, T., & Knutsson, H. (2016). Cluster failure: Why fMRI inferences for spatial extent have inflated false-positive rates. *Proceedings of the National Academy of Sciences, 113*, 7900–7905.
- Gelman, A., & Loken, E. (2013). The garden of forking paths: Why multiple comparisons can be a problem, even when there is no “fishing expedition” or “p-hacking” and the research hypothesis was posited ahead of time. Retrieved from [http://www.stat.columbia.edu/~gelman/research/unpublished/p\\_hacking.pdf](http://www.stat.columbia.edu/~gelman/research/unpublished/p_hacking.pdf)
- Healey, M. P., & Hodgkinson, G. P. (2014). Rethinking the philosophical and theoretical foundations of organizational neuroscience: A critical realist alternative. *Human Relations, 67*, 765–792.
- Karaman, M., Nencka, A. S., Pierce, I. P., & Rowe, D. B. (2014). Quantification of the statistical effects of spatiotemporal processing of nontask fMRI data. *Brain Connectivity, 4*, 649–661.
- Lee, N., Senior, C., & Butler, M. (2012). Leadership research and cognitive neuroscience: The state of this union. *The Leadership Quarterly, 23*, 213–218.

- Lieberman, M., & Eisenberger, N. (2008). The pains and pleasures of social life: A social cognitive neuroscience approach. *NeuroLeadership Journal*, *1*, 1–9.
- Lindebaum, D. (2013). Pathologizing the healthy but ineffective: Some ethical reflections on using neuroscience in leadership research. *Journal of Management Inquiry*, *22*, 295–305.
- Lindebaum, D., & Zundel, M. (2013). Not quite a revolution: Scrutinizing organizational neuroscience in leadership studies. *Human Relations*, *66*, 857–877.
- Meyer, M. L., Davachi, L., Ochsner, K. N., & Lieberman, M. D. (2019). Evidence that default network connectivity during rest consolidates social information. *Cerebral Cortex*, *29*, 1910–1920.
- Poldrack, R. A. (2011). Inferring mental states from neuroimaging data: From reverse inference to large-scale decoding. *Neuron*, *72*, 692–697.
- Poldrack, R. A., Baker, C. I., Durnez, J., Gorgolewski, K.J., Matthews, P. M., Munafò, M. R., et al. (2017). Scanning the horizon: Towards transparent and reproducible neuroimaging research. *Nature Reviews: Neuroscience*, *18*, 115–126.

**Part IV**  
**Connecting Within Organizations**



# Perspectives on Inclusive Leadership for Statisticians in Industry



Ellen Sim Snyder, Lisa Lupinacci, and Nora Vele

**Abstract** Companies, managers, and individual contributors all have important roles in establishing and maintaining a culture of diversity and inclusion. This chapter discusses drivers of diverse workforces, bias, and ways statisticians in industry can show leadership and take action to build a strong culture of diversity and inclusion in their organizations.

## Introduction

In the book *Leadership and Women in Statistics*, Daniel Solomon points out that the motivation for diversity in a workplace goes beyond the notion that recruiting, retaining, and developing a diverse workforce is the “right thing to do” (Solomon, 2016). Indeed, for many companies at which statisticians work, it is also a “business imperative” because it is directly linked to their mission of delivering useful or valuable products or services to a large, diverse set of customers. At least two key aspects of such a mission that are enabled by workforce diversity are customer-centricity and innovation, widely understood to be key factors in the success of many companies (Bourke & Dillon, 2016). Thus, diversity in a workforce in industry is important from both a human and a business perspective.

Diversity in markets and diversity in customers are two global trends that are impacting and will continue to impact the success of many companies (Bourke & Dillon, 2016). Many companies are now producing goods and services for a global

---

E. S. Snyder (✉)

Biostatistics and Research Decision Sciences, Merck & Co., Inc., North Wales, PA, USA  
e-mail: [ellen\\_snyder@merck.com](mailto:ellen_snyder@merck.com)

L. Lupinacci

Biostatistics and Research Decision Sciences, Merck & Co., Inc., North Wales, PA, USA  
e-mail: [lisa\\_lupinacci@merck.com](mailto:lisa_lupinacci@merck.com)

N. Vele

Merck & Co., Inc., Kenilworth, NJ, USA  
e-mail: [nora\\_vele@merck.com](mailto:nora_vele@merck.com)

marketplace, and, thus, their customer base is very diverse in multiple dimensions (dimensions we can see such as race, ethnicity, gender, and visible disability, and those we cannot see such as LGBTQ, veteran status, and interfaith). As of 2018, the United Nations estimates that half of the world's population resides in seven countries: China, India, the United States, Indonesia, Brazil, Pakistan, and Nigeria (Hackett, 2018). In addition, emerging economies like China, India, Indonesia, Brazil, Russia, and Mexico will dominate the list of the world's ten largest economies and (with Turkey) will increase their share of world GDP to almost 50% by 2050 (PwC, 2017). Most marketed products are intended for customers who also span genders, ages, and lifestyles. As of 2018, 49.5% of the world's population are women, 15% live with a disability, and, in the United States, it is estimated that at least 7% is LGBTQ (Disability Inclusion, 2019; Green, 2016; The World Bank Data, 2018). With easy access to digital devices, these customers are becoming more and more aware of the number of choices they have in a marketplace and are expecting products that are more personalized to their needs (Bourke & Dillon, 2016). Thus, it has become more important for companies to produce products and services that are customer-centric. It is logical to argue that effective development of products and services that are targeted at a highly diverse customer base requires employees who represent that customer base. Who better can understand what is needed and valued by those customers? Thus, it makes sense from a customer-centricity perspective to recruit a diverse workforce.

The ability to develop innovative products is also important in today's business world, and diversity can play a key role in innovation at a company (Bourke & Dillon, 2016). *Diversity* generally refers to differences among people with respect to characteristics such as gender, ethnicity, age, sexual orientation, social class, religion, and physical ability. Because a person's experiences and circumstances heavily influence his or her thoughts and opinions, diversity in backgrounds among a group of employees can lead to diversity in the thoughts, ideas, and perspectives those individuals bring to a work project. In a 2014 survey of 1500 senior executives, the Boston Consulting Group found that the best innovators "cast a wider net for ideas" than other innovators (Boston Consulting Group, 2014). Thus, a company that effectively leverages the diverse thoughts and ideas of a diverse workforce could have an advantage with respect to innovation.

As we move into the third decade of the twenty-first century, organizations have learned that diversity in a workforce by itself is not enough. A company will realize the maximum benefit from the diverse thoughts and ideas of a workforce only if those ideas are freely expressed by employees and valued by decision-makers, and this requires an inclusive workplace. *Inclusion* refers to the mechanisms by which employers make employees of diverse backgrounds feel included and engaged in the workplace to the extent that they contribute to their full potential. The importance of inclusion to a diverse workplace is summarized by Peggy Yu, CEO of Stack Education, who writes, "Inclusion is the only scalable way to build diversity within an organization. Without thoughtful and deliberate discussion and action to cultivate an inclusive environment, all the energy and resources spent on recruiting a diverse

workforce are for naught” (Yu, 2018). Thus, in order for a company to fully leverage the diversity of its talent, it must examine how well it promotes inclusion.

Behaviors that promote inclusion in a workplace are enabled by “bias literacy,” an understanding or knowledge of bias and how it impacts thoughts, actions, and decision-making. Once bias is well understood, it is simpler to recognize its sources and take action to prevent it from influencing the workplace. There are two main types of bias that should be considered: conscious bias and unconscious bias. Conscious bias is, of course, bias of which we have a conscious awareness. Unconscious bias is bias that influences our thoughts and actions without our being aware of it.

In this chapter, we will discuss drivers of diverse workforces in industry, sources of bias in the workplace, and ways that industry employees can show leadership and take action at the corporate, managerial, and individual levels to promote diversity and inclusion in the workplace.

## **The Company Perspective**

Corporate policies and perspectives shape the environment in which all industry employees work and broadly influence attitudes regarding diversity and inclusion. These attitudes can heavily influence how individual managers recruit and retain a workforce and how they maximize the contributions of and ensure the advancement of their employees. Thus, it is critical for companies to have bias literacy, to value diversity and inclusion in corporate policies and to commit to diversity and inclusion in their leadership styles and daily practices. Incorporating diversity and inclusion into the culture of a company requires a genuine commitment that extends beyond merely the words that define it and the programs that comprise it. This commitment includes setting the vision, delivering the right messages to employees, implementing programs and business practices that integrate diversity and inclusion into the business through vital strategic work that spans the organization, and sustaining those programs and practices even when it becomes difficult.

Bias literacy at a company should include an understanding of the demographics of the current workplace relative to the talent market and an understanding of whether progress is being made to achieve greater representation of traditionally underrepresented groups in the workforce. This applies to all levels of an organization. In 2015, the Equal Employment Opportunity Commission (EEOC) produced a report showing that although the percentage of women and non-Caucasian ethnic groups in professional jobs increased in the United States between 1966 and 2013, the percentage of women and non-Caucasian ethnic groups in managerial and official leadership roles increased by smaller percentages (American Experiences Versus American Expectations, U.S. Equal Employment Opportunity Commission, 2015). These data show that while employers are making progress in the hiring of more diverse workforces, there may still be bias in decisions to promote certain groups of employees or trust them with greater responsibility. Therefore, companies

should not only compare the demographics of their overall workforce to those in the available talent pool but should also assess whether there is greater representation of traditionally underrepresented groups at lower levels than at higher levels in their organization. Suspected bias in either dimension can then be addressed.

An important way to build inclusion into everyday behaviors at a company is to enable it with company policy. Inclusive policies and programs value the knowledge, insights, and perspectives of all employees in an open, trusting, and non-judgmental environment. They also promote feelings of inclusion in employees, which are driven by perceptions of fairness and respect, a sense of personal value, and a sense of belonging. Some of the most important policies companies can adopt to encourage inclusion are those that enable work-life integration. Work-life integration policies should support a broad array of programs that appeal to employees at all stages of life. Employees who benefit from work-life integration programs include, but are not limited to, employees who manage multiple responsibilities both at home and in the workplace, employees who are caregivers to elderly parents, employees who are single-head-of-household parents, employees with apparent or non-apparent disabilities, and employees who have religious obligations. Indeed, there are hardly any employees who do not somehow benefit from work-life integration programs offered at their company. Some examples of work-life integration programs that companies may consider are onsite childcare, ability to work from home or telecommute, flexible work schedules, paternity leave, adoption services, onsite prayer rooms, onsite new mother/nursing rooms, and domestic partner benefits for LGBTQ employees.

Supporting Employee Resource Groups (ERGs) is another way that a company can intentionally drive the practice of inclusion. An ERG (or affinity group) is a group of employees with a common interest around a specific dimension of diversity. The employee-members of the ERG serve as an educational and cultural resource for other employees and business groups within a company, serve as advocates within the company, and serve as ambassadors outside the company in ways that will enhance the company's reputation and community presence. For example, companies partner with ERG's in the design and execution of events to honor diversity by celebrating nationally recognized heritage months, such as Black History Month (February), Women's History Month (March), Pan-Asian Heritage Month (May), LGBT Pride Month (June), Hispanic Heritage Month (mid-September to mid-October), National Disability Employment Awareness Month (October), and Native American Heritage Month (November). ERGs can be highly impactful. In a 2017 survey conducted by Fairygodboss, approximately 70% of the women surveyed said that their women's ERG was responsible for influencing changes in policy at their place of employment (Employee Resource Groups for Women, Fairygodboss, 2017). ERGs also provide excellent opportunities for employees who share similar affiliations to get together, network, engage in community outreach, host cultural celebrations, and participate in leadership development opportunities, such as mentoring programs and talks by guest speakers who discuss important topics in leadership.

Recognizing the tremendous value and business insights of ERGs, the role of ERGs at some companies has changed, and they have evolved into Business Resource Groups (BRGs). BRGs have the additional role of accelerating advancement by providing targeted leadership opportunities and leveraging business insights around specific consumer constituencies to drive business results. They play a vital role in supporting decisions made by leadership that can be directly integrated into the strategic business plan of the organization for market share growth. For example, an LGBTQ BRG can provide insights on HIV product development and volunteer for outreach activities. They can identify opportunities for businesses to engage with LGBTQ consumers through pride events. They can also be a resource for recruiting STEM talent into the organization by participating in LGBTQ STEM-focused career fairs.

A key role of a Human Resources department in fostering diversity and inclusion at a company is to equip people managers, including those in senior leadership positions, with the education, resources, and communication tools required to ensure employee engagement and productivity and to create and maintain a sense of belonging in the workplace. These efforts, in turn, reduce the risk of employees feeling excluded, isolated, and not valued in the workplace and prevent the associated negative impact on employee motivation and performance. Unconscious bias education is an extremely important element in promoting diversity and inclusion. It is important for leaders to be aware of the impact of bias on how they engage with their talent, whether it's a candidate they are considering for a job, someone to whom they are providing performance feedback, or someone they are considering for a promotion. To support leaders at our company in making critical talent and business decisions, the Human Resources Department launched a resource in the form of a toolkit to allow leaders to take a moment to examine their thinking and the implications of their decisions. When conducting each employee evaluation, the leaders were encouraged to ask themselves the questions provided in the unconscious bias learning materials. As a result, in group meetings, leaders began to observe their teams challenging each other on the decisions being made and intentionally calling out bias when they observed it.

A Human Resources department can also help with the recruitment of a diverse workforce. From a recruitment perspective, the demand for STEM talent (including the demand for statisticians) is intensifying in industry, and the available pool of STEM talent includes a large number of women and non-Caucasians. Organizations need to broaden their reach to attract this valuable talent and use best practices related to diversity and inclusion to retain them. In conversations with colleagues at other companies, we often hear complaints about the lack of diverse talent available. However, the perception that there is a lack of diverse talent is likely caused by the fact that we repeatedly "fish in the same pond" for candidates. One way that we can expand our reach is for human resource departments to create opportunities for managers to engage with talent from communities that are different from the usual pool and gain experience with their work. Internships, for example, are a great way for managers to gain experience with talent that comes from different backgrounds, colleges or universities, or geographic areas. Mentoring such talent

over a period of several months can provide insights into similarities and differences in thinking across different types of individuals and cause managers to consider how those differences might be leveraged to accomplish business goals. Another way to reach a broader talent pool is to leverage the networks of employee resource groups. Managers can join these networks, offer to be sponsors of them, and engage with them to challenge their own biases.

Corporate commitment to diversity and inclusion is fundamental to its success. Without expectations set by senior leadership and policies in place to enable a culture of diversity and inclusion, it may be difficult for individual managers and employees to implement programs and engage in activities that promote these important values. Not only does company commitment create an environment in which all employees can thrive and grow, but employees who have a sense of value and belonging will share those experiences within their communities and networks and will help position the company as an employer of choice among potential diverse candidate pools.

One very important aspect of corporate commitment to diversity and inclusion involves giving diversity initiatives the time they need to succeed. In the report “The Inclusive Leader: Optimizing Diversity by Leveraging the Power of Inclusion,” Andres Tapia shows that “homogenous teams in the early stages outperform diverse ones because of the disruption and conflict that can result when different perspectives, experiences, backgrounds, thinking, and communication styles are merged. But diverse teams well managed by inclusive leaders can significantly outperform well-managed homogenous ones over time” (Tapia, 2019). Thus, companies must resist the urge to abandon policies or initiatives when presented with challenges. Companies must accept and push through the friction that may arise during the early stages of diversity programs to experience the longer-term incremental benefits of diversity and inclusion.

## **The Manager’s Perspective**

Whether managing a small group, managing a large group, or supervising statisticians assigned to a given project, a leader of a statistical organization in a large company must model the behaviors that he or she expects his or her employees to demonstrate. Therefore, while it is important for managers to provide employees with the right messaging regarding diversity and inclusion, it is even more important that those managers take action to put in place practices and policies that ensure the success of this mission. The ideas of equality and fairness across diverse groups of people can be interpreted in different ways. Equality and fairness can sometimes be understood by employees to mean that everyone receives the same project opportunities and the same rewards. As employers, however, we more often adopt the approach that project opportunities and rewards are largely merit-based; that is, they are based on demonstrated performance or on perceived future potential. In this setting, the principles of equality and fairness demand that we judge performance

and potential for every employee on the same scale or on the basis of the same criteria, and to truly promote diversity and inclusion, we need to make sure that those criteria are free from bias, both conscious and unconscious.

The first step in eliminating bias is to acknowledge that we are all biased. The more we are aware of this fact, the more effective we will be in reducing the impact of that bias on our thinking and our actions. Statisticians, in particular, may believe that they are less prone to bias, simply because they spend more time thinking about bias and its impact than other people do. However, it is important for statisticians to understand that they are also prone to bias and to take steps to address this fact.

Conscious bias is often easier to address than unconscious bias. If we know, based on upbringing or prior personal experience, that we tend to favor certain groups of people, we can make a conscious effort to try to include and better understand individuals who are not among those groups. Note that eliminating bias does not mean replacing one bias with another. Occasionally, when addressing a conscious bias, we can go too far in the opposite direction. In our efforts to not be biased against one group of individuals, we can put in place a process which favors those individuals and, in turn, disadvantages others. While this may provide more opportunities and visibility to traditionally disadvantaged groups, it is rarely good for business and fails to adhere to principles of fairness. Unconscious bias is harder to address because we do not know when it enters into a decision-making process. As employers and leaders, therefore, we need to examine the processes that govern the daily activities of our employees and make every effort to ensure that these processes are free of both types of bias.

One effective way to reduce the impact of unconscious bias on the hiring process is to establish required skill sets for various jobs and carefully examine those skill sets to ensure they are not biased against individuals with particular genders, ages, disabilities, ethnicities, or lifestyle preferences. Establishing an unbiased list of required job qualifications can sometimes be quite challenging because the desired skill set for a particular job may at times include characteristics that are more frequently found among members of a particular culture or gender. For example, in large corporations, employees usually need to collaborate with many groups of colleagues to be successful. For a large corporation in the United States, a major success factor for effective collaboration is the ability to communicate effectively in English. Mastering and demonstrating aptitude for the English language is frequently more challenging for statisticians who did not grow up speaking English as their first language than for statisticians who did. An employer who sets up criteria for higher-level jobs at a large corporation will almost always be highly concerned about effective communication skills, so this particular criterion automatically introduces a culturally-based bias. In this case, the criterion for effective communication is business-critical and cannot be omitted from the list of desired skills. However, employers can put measures in place to try and remove disadvantages that impact an entire group of people in their organizations. Providing company-sponsored access to English-language courses or technical presentation or writing courses for statisticians who do not speak English as a first language would be an appropriate way to promote diversity and inclusion. Providing access to such a

course does not place those individuals with less developed English-language skills at an advantage relative to their peers; it simply helps to eliminate or reduce the impact of a disadvantage inherent to their situation.

Unconscious bias very often takes the form of hiring or promoting individuals that are like oneself. Successful individuals, like those in positions of leadership, have a natural tendency to believe that the personal and professional characteristics they possess contributed heavily to their success. Therefore, their models of success reflect a particular set of characteristics that are similar to their own, and when they see those same traits in others, they assume those same characteristics will lead those individuals to success as well. For these leaders, a low-risk way to ensure the continued success of their projects and companies would be to hire or promote people that they know have all the “right” qualities. The flaw here is in not recognizing that other characteristics might also lead to success. Even when a leader recognizes this, he or she is still faced with the challenge of whether to take a risk to find out if those characteristics can also lead to success.

This type of unconscious bias can be a factor in the inability of women to achieve higher roles in some organizations. Men and women sometimes take different approaches to getting work done. A woman might opt for a flexible work schedule in which she can accomplish all the work associated with her role by fitting in her hours at different times or in different locations than a man who works a set number of consecutive, dedicated hours in the same office every day. Both may get the job done in the same time frame and with the same level of quality and leadership, but if the hiring manager is a man who takes the latter approach to getting work done, he may doubt whether the woman’s work pattern is as productive as his. There may even be questions about her dedication and focus, even though the ultimate products and outcomes are the same. Interestingly, this type of bias seems to present itself more as women ascend to higher levels of leadership. The same woman who has demonstrated a high level of productivity, quality, and leadership on a flexible schedule at lower levels of responsibility may have her abilities suddenly called into question as the level of responsibility rises. We need to ask ourselves in this situation whether we have a solid reason to believe that her work pattern will prevent her from doing the higher-level job. We also need to take a close look at our “qualifications” for the higher-level job to ensure that there is no qualification that automatically favors someone who does not have a flexible work schedule unless it is absolutely business-critical.

Flexibility in work schedules and work locations can be a very important factor in retaining a diverse organization. Most statisticians have careers that span decades. During those decades, many employees’ personal lives go through a great many changes. Flexibility allows employees to continue to add value to the company while managing other, often complex, issues in their lives. Often, these issues are temporary, but sometimes they last longer. Common examples of flexible work arrangements include flexible hours, part-time work, and working in a location that is remote from the main office. Employees (often women) who need to balance work demands with family demands and employees with physical challenges due to medical conditions are especially drawn to flexible work benefits and will often work very hard to ensure the success of the arrangement.



There are several keys to making flexible work arrangements successful. At many companies, it is difficult for a statistician to perform effectively without a solid foundation in the needed job skills and strong collaborations with key members of his or her work team. Most highly successful flexible arrangements begin after the employee has worked full time at a primary company location for a period of time. This initial work experience solidifies the statistician's knowledge of the job requirements, establishes strong relationships with stakeholders, and, most importantly, builds trust with co-workers that he or she will need to leverage when functioning under special work circumstances.

Leaders considering whether to approve a flexible work arrangement should assess the strength of the individual employee's fundamental skill set, his or her performance level, and his or her demonstrated ability to adapt to changing circumstances, if such behavior has been observed. Flexible work arrangements that do not work (that is, those that cause business goals not to be met) undermine the entire notion of flexible work and its acceptability in the workplace. Therefore, flexible work arrangements should be considered very carefully, and an arrangement that lacks value for the company must not be approved.

Once granted, the success of flexible work arrangements relies on the manager's ability to set expectations and monitor work quality and on the employee's ability to maintain strong relationships with teams and maintain a high level of performance such that the arrangement does not cause undue hardships on the project. Managers should help to ensure the success of flexible work arrangements by setting clear (and realistic) expectations for performance, workload, and responsiveness to colleagues, by seeking frequent feedback from the employee's team on the perceived success of the arrangement (or lack thereof), and by checking in with the employee frequently to discuss challenges and best practices. Managers should set the same expectations with respect to workload and quality for individuals with flexible arrangements that they would set for those who do not have such arrangements (the exception would be for part-time employees who would likely have an appropriately lighter workload). An employee with a flexible work arrangement must understand that he or she needs to meet his or her manager's expectations and his or her work team's expectations in order for the arrangement to be successful. Some employees with flexible work plans are so successful that many of their team members do not even realize that they have a special work arrangement. This is clearly the ideal, and it is not always achievable, but at the very least, the employee's project team should be able to expect the same contributions to the project from them that they would expect from someone without a flexible work situation. It is the responsibility of the statistician with the flexible arrangement to ensure this happens, even if it means additional effort, such as more advanced planning or more proactive communication.

*Lisa's Experience—I have personally benefitted greatly from flexible work arrangements. For 8 years after my first child was born, I worked on a 60% part-time schedule. During this time, I served as a manager and a project leader. The ability to plan and manage time effectively was critical to the success of the part-time work arrangement. As a part-time employee with a leadership role, I put in extra time and effort to plan ahead and make sure my team had everything they needed from*

*me to keep their projects moving during my “off/unpaid time.” Occasionally, I also had to work during my “off/unpaid time” to make sure the project stayed on track. However, even when I worked more than my scheduled 60%, the overall benefit for me and my family were still well worth the occasional sacrifices. I have had colleagues who have tried similar arrangements and were dissatisfied. They found the sacrifices of extra planning and overtime not worthwhile. For some, working 110% on a 100% salary is more palatable than working 70% on a 60% salary. Each employee considering a flexible work arrangement should be aware that extra effort may be needed at times to ensure the success of the arrangement and to make sure the balance of work time and off time has value to them.*

*As my children grew older, I returned to full-time work but utilized a flexible work schedule. I flexed my hours earlier in the day and worked from home on many afternoons and evenings in order to achieve both my work and family goals. Under this newer arrangement (which is still in place today), I served effectively as a drug development team leader and, more recently, as a department head. This flexible work schedule has, in some ways, actually increased my productivity. As I took on higher-level leadership roles, my calendar became more and more crowded with meetings, many of which were one-on-one coaching, status-tracking or problem-solving meetings with members of my department. The volume of meetings allows little time for accomplishing work on my own initiatives. However, the pattern of working from home in the late afternoons forces me to attend only the highest value meetings in this time frame, freeing up a lot of my afternoon time for meeting deadlines on document reviews and for working on deliverables associated with initiatives I lead. In fact, I’ve found that the time I spend waiting for my daughter to have a music lesson or for my son to participate in a soccer practice is the perfect opportunity to focus on reviewing documents or mapping out a plan for a project that I’m leading without other distractions. Thus, sometimes, having different patterns of work allows for better proactive time and work management.*

Arrangements with flexible work locations have different considerations for employees and managers than flexible work schedule arrangements. Advances in technology over the past 20 years or so have made it possible for employees to work quite successfully from a variety of work locations. In smaller companies, a large proportion of employees may work from home or from offices that are distant from the main company location, and in some very small companies, nearly all employees may work from their homes. In such situations, flexibility in work location would be considered more of a norm and less of a special situation. Therefore, this section focuses on employees of larger companies with a single or very few primary locations where most employees work and fewer employees who work from alternate locations on a permanent basis. “Remote” workers will refer to employees who spend nearly all of their time working at a non-primary work location, while a very large number of their colleagues work at a primary location.

Remote work arrangements can be very appealing to employees with family considerations that require them to relocate their permanent residence (for example, if a spouse needs to relocate because of a new job). They can also be very effective arrangements for employees with physical challenges due to medical issues. As with

flexible work schedule arrangements, managers and leaders must be clear about expectations for employees who work outside of primary company locations. If there is an expectation for the employee to work for any part of the year at the primary location, this should be specified upfront as well as any expectation that the employee will fund his or her own travel to the primary location or other business-critical events. Managers should strive for fairness in the amount of re-imbusement provided for travel among remote workers. A good way to achieve this is to establish a set of rules that will apply across remote work scenarios. It seems reasonable that the rules may vary based on employee seniority and project responsibilities, but the rules should ensure that employees in similar situations are treated similarly.

*Nora's Experience: Several years before the World Wide Web went live to the world and the Internet became mainstream, I was injured and placed on long term disability (LTD). During my rehabilitation, it became evident that I could no longer commute to work to perform my job in the office. When I was no longer considered 100% disabled, Human Resources informed me that LTD leave was no longer an option, and I would need to return to work by a certain date or be terminated. My manager was increasingly concerned about retaining me and offered me the opportunity to work part-time from home until I was fully recovered. In collaboration with the Human Resources Department, my manager came up with a creative compensation solution; I would be paid by the company for the hours I could work but continue to receive LTD benefits for the balance of full-time hours that I could not work. Partial compensation was a novel idea and one that the company agreed to pilot. My manager arranged for me to use a company-issued computer while at home, and my husband set up a home office with all the amenities I had at work. A co-worker dropped off daily assignments, which enabled me to be one of the first employees to telecommute at the company. Working with my rehabilitation counselor, manager, and the Human Resources Department, I successfully returned to work full-time within a year. Many years later, I continue to leverage a flexplace schedule as needed. If it were not for these special arrangements and support, I would not have been able to keep my job, and my company would have lost an experienced employee.*

It is important for managers to consider that there may be job roles that cannot be effectively filled by employees working in remote locations. There may be roles that have high visibility with senior company leaders or that have responsibilities that are not easily fulfilled by remote workers. Careful thought should be given to allowing employees who work remotely on a permanent basis to hold management positions when all or most of their employees will be at the primary location. A remote worker may be a very high performer, may have a great deal of potential to be an effective manager, and may be completely capable of putting in the extra effort required to maintain strong relationships with their employees. Under such circumstances, a management role might be seen as a great development opportunity for the remote employee. In this case, however, the senior hiring manager also needs to consider how the arrangement will impact the growth and development of this person's employees at the primary work location. Even when a remote manager puts additional measures in place to maintain strong communication with

his or her employees, a senior hiring manager needs to consider whether the more introverted among those employees would be inclined to go to the extra effort to track the manager down for advice when a problem arises, or whether they would just find another leader who is more geographically convenient. He or she should also consider whether the remote manager's employees would have the leadership or even the luxury to forestall an urgent team decision if a time zone difference between the employee or his/her manager will cause a delay and whether the remote manager would have enough visibility into the larger organization to find development opportunities for his/her employees that cross organizational lines when needed. Any or all of these considerations might cause hesitation in the decision to choose a manager with a remote work location. In some cases, these arrangements may work; in others, they may not. In either case, it is important to consider the feelings of inclusion among those who would potentially report to the remote worker as well as those experienced by the remote worker.

It is important for managers of remote workers to continue to find development opportunities for those workers. A remote employee who is performing similarly to workers at the primary location may not have many limitations on the roles they can be offered. It is the responsibility of the manager to continue to find roles that have value for both the company and the employee, and it is the responsibility of the employee to maintain a high level of performance, to express interest in broader roles and to ask about his/her own development. If there are job roles, however, that remote employees are not eligible to fill, managers should clearly communicate this to any employee considering a remote work arrangement before the arrangement is approved.

For flexible work arrangements to be successful, managers must critically assess each candidate's potential to make them work, must put the right monitoring measures in place, and must give them a chance to succeed. It is important that managers not make assumptions that performance levels will drop, as this mindset contradicts the ideas of diversity and inclusion. Most people who request flexible work arrangements are very grateful for such arrangements and will go the extra mile to make sure they work well.

Another important way that leaders can promote diversity and inclusion is to discourage "covering," or, rather, to encourage not covering. In human resources parlance, covering occurs when an employee hides a key aspect of his or her life from his or her work colleagues for fear of being judged negatively or worse, being the target of discrimination and bias. Most people adopt different behaviors at work and at home. At work, we are often more formal, more professional, and more serious than we are in our homes and with our friends and families. This alternate work persona helps us achieve certain goals at work that we don't need to achieve outside of work. Covering, however, is something more significant. Covering involves an employee consciously hiding an aspect of his or her life or personality that he or she should be able to reveal at work without being unfairly judged. It is often practiced by members of the LGBTQ community who feel that knowledge of their lifestyle preferences will cause their work peers and managers to treat them differently and, often, negatively. Covering is also sometimes practiced

by employees with children, most often women with children. Some employees who have children will try to hide the fact that they need to leave work early on a given day for a school activity or to see their child participate in a sporting or other event. Even though, in our experience, the majority of parents who attend school events make up the work they missed in the evenings or on weekends, many feel their work ethic or dedication to their jobs might be questioned by their co-workers or managers, particularly those who do not have children or do not prioritize their children's activities. Leaders need to avoid this type of thinking and discourage it if they hear it discussed among their employees.

There are other ways to actively discourage covering as well. One way is for a leader to plan informal lunches to connect groups of employees. As people talk (and eat), the leader can make sure the discussion at the table incorporates topics like vacations, social activities, or families. If the leader is willing to share a bit of his or her personal circumstances, it will likely encourage others to do the same. Leaders with children (or grandchildren) can talk about their family adventures and challenges, so that their employees know that they also balance family and job constraints. We have known leaders without children to talk about nieces and nephews, pets, hobbies, and other aspects of their lives that they balance with work. Leaders should be careful in such conversations not to ask employees pointed questions about their personal lives but to create an environment where employees feel free to share. The leader should also make sure that he or she reacts positively to all information that is shared. A key aspect of inclusion is multicultural awareness and acceptance. Activities such as these informal gatherings enable leaders and employees to gain a better understanding of each other. Since human beings generally have an inherent uneasiness about that which is unknown or "different," this better understanding should help to reduce bias in that it will give employees more knowledge with which to approach, accept and bridge the differences among them. This better understanding of colleagues will also help employees to identify areas of commonality with each other that were previously unknown. This will make employees feel more included in their work group and can also help leaders change their assumptions about employees and their capabilities. Since the foundation of unconscious bias is assumptions we make based on prior experience, broadening our experience will help combat unconscious bias.

Most often, when we think about diversity and inclusion, we focus heavily on gender, ethnicity, and lifestyle preference. An area that receives less attention is age bias. Age bias, especially in a large scientific organization, can work in both directions. In a scientific field, like statistics, new methods, techniques, and technologies are continuously under development. In fact, at the current time, there is a larger gap in the technological capabilities of older and younger generations of statisticians than has ever before existed. The oldest generation of statisticians remembers using punch cards to program computers, while the youngest takes only minutes to detect trends in massive datasets. In this type of environment, it is easy for younger statisticians to assume that the thoughts and practices of older statisticians are outdated. In a field where problem-solving is fundamental, younger statisticians might think of older statisticians as being less quick or less sharp than younger

statisticians. Often, however, this is not the case. The fundamental statistical knowledge of many older statisticians is still as applicable to statistical problems today as it ever was. In fact, many long-term statisticians have stronger fundamental knowledge of certain methods because they had to solve more problems by hand with less access to computing power. In addition, with age comes experience, and experience leads to better strategic thinking and often to more creativity. It is the responsibility of managers and leaders in statistical organizations to recognize these strengths and put more senior statisticians in roles where they can leverage their experience and impart it to younger generations. As older-age bias is enabled by senior employees who become too entrenched in the way “things have always been done,” leaders of statistical organizations need to encourage more experienced employees to consider new ideas, to apply study designs and analysis techniques across research areas and to stay current on methodology.

The age bias can also work against younger employees. Often, organizational leaders at large companies, especially heads of departments, are representative of the older half of the age distribution at the company. When those leaders need an employee to lead a new initiative or to head a high-profile project, they most often pass over young, eager, newer statisticians in favor of more experienced employees. This is because such roles require broad, strategic thinking which is typically seen among statisticians with a significant amount of exposure to various statistical problems. However, without opportunities to fill impactful roles, younger statisticians will not grow and develop or gain the experience they need to continue to add value to a company. Therefore, managers and leaders should seriously consider stretch assignments for younger statisticians and should put appropriate measures in place to mentor, coach, and support them. When an important departmental initiative arises, leaders could consider choosing both an experienced and a less-experienced statistician to co-lead the project instead of choosing just one of them. The more experienced statistician can bring the broad, strategic perspective and the younger statistician can bring newer methods and ideas. The manager, of course, should set expectations for the relationship and positively reward both behaviors.

Finally, when establishing a strong culture of diversity and inclusion, managers should find ways to make sure diversity and inclusion behaviors are rewarded. Many companies have reward systems wherein managers (and sometimes peers) can reward specific behaviors or project work they find worthy of extra recognition and appreciation (that is, above and beyond normal compensation and performance evaluations). Managers who use such systems to reward diversity and inclusion behaviors will likely find those behaviors repeated.

Because they represent the company to their employees and because of their ongoing influence over employees, managers bear significant responsibility for creating a lasting culture of diversity and inclusion at a company. A key responsibility for managers in creating such a culture is to reduce bias (conscious and unconscious) in decision-making at all points in the employee life-cycle including the recruiting, retaining, developing, promoting, and exiting of employees. Managers also have a responsibility to practice inclusion and set a model for acceptance of differences

among employees, using all company policies and resources available to them. Finally, managers have a responsibility to find ways to leverage each employee's unique strengths and perspectives to maximally benefit the company, and this involves a high level of engagement with employees and an unbiased understanding of their goals, talents, and challenges.

## The Individual Contributor Perspective

While companies and managers have responsibility for broadly creating and maintaining a culture of diversity and inclusion in the workplace, there is much that individual contributors (e.g., statisticians) can do through their own leadership practices to enable, support, and promote these values as well.

One of the most important and simple things an individual contributor on a team can do is make it a point to get to know all team members better, especially those with characteristics (race, age, ethnic background, etc.) different from their own. As mentioned previously, familiarity with one's peers removes fear of the unknown and identifies areas of commonality which can be built upon when a shared project requires problem-solving or resolution of differences of opinion. By reaching out to initiate conversations or inviting colleagues to lunch, one can start to create an environment of inclusion where team members are genuinely friendly with each other and have easy and open communication. Teams with excellent communication between members simply function better. Knowing colleagues better makes it easier to pick up the phone and call on them to discuss ideas and issues when the need arises.

It is also important for individual contributors to educate themselves about unconscious bias. Individual contributors can do this by reading about unconscious bias, by taking an (online) unconscious bias assessment (<https://implicit.harvard.edu/implicit/aboutus.html> [choose "Take a Test"]), and by taking training about unconscious bias if it is offered. Increasing one's awareness of his or her own unconscious bias can be an effective way to begin to understand how one's decisions and conduct may be affected by it and how to begin to reduce and remediate its occurrence in one's future interactions with others. Heightened awareness can be shared with and modeled for other colleagues, and this will ultimately serve to lessen its occurrence and impact in the workplace.

Another important way that individual contributors in underrepresented groups can promote diversity and inclusion in their organizations is by applying for higher-level and/or management positions. Women and members of other underrepresented groups may hold themselves back from applying for higher-level positions because they may feel they don't meet all the requirements. They may also be discouraged because they are not able to do the higher-level job exactly the way the incumbent does it (for example, by keeping the same hours the incumbent keeps or working in the location where the incumbent works), and they incorrectly assume that is the only acceptable way to do it. Individual contributors should try to avoid thinking

this way and should encourage each other not to think this way. Success can have more than one image, and employees need to consider this with respect to their own situation and development opportunities.

Individual contributors can also foster inclusion by respecting and supporting colleagues with work arrangements that are different than their own. For example, an individual contributor can treat remote employees the same way he or she would treat colleagues located at a primary worksite and not reduce information shared with them or the frequency of interactions with them simply because they are remote. Individual contributors can also become familiar with and accommodate flexible work time schedules of others when planning meetings, or they can offer to assume some of the work of a colleague on medical leave. Of key importance, they can withhold pre-judgment about whether a colleague that has a flexible work arrangement which enables them to meet both their professional and personal responsibilities can pull his or her weight on the project.

*Ellen's Experience—Upon returning to work following the birth of my first child, before the days of easy remote connectivity and alternative work arrangements, I requested and was granted the following flexible work time arrangement. I arrived at the office by 7:00 a.m., worked through lunch and then left the office at 3:00 p.m. At the time, the vast majority of employees were expected to be in the office from 9:00 p.m. to 5:00 p.m. This modified schedule, together with my husband's later work schedule, was necessary for our child's caregiver to be able to accommodate her own children's schedules. I relished my work time between 7:00 a.m. and 9:00 a.m. when few others were in the office and I could be extremely focused, efficient and productive. I was the lead statistician for a new drug application and my team did not have difficulty accommodating my alternative work schedule. In fact, our team members worked so well together that no one had to work any overtime (which was uncommon for this type of project) and we delivered the statistical results significantly earlier than the planned deadline. This demonstrated to management that flexible arrangements can really work. When it made practical sense for me, I transitioned to a later work schedule with more traditional hours. After this positive example of a flexible work time schedule, another team member adopted a flexible work location arrangement, which the rest of the team readily accommodated as well. Today, flexible work time and/or location arrangements are much more common than they were in the past, and this is likely due to some of these very early success stories.*

*After a childcare leave following the birth of my third child, I returned to work under a part-time 'slot share' arrangement. For this flexible work arrangement, I shared a full-time headcount with another employee (we each worked 60%) but our levels and functions were unrelated. During this time, I worked on projects and activities that were valuable to the programs I supported, but the deadlines were not as strict and demanding as those typical of new drug applications. These projects were interesting and new for me (e.g. designing and analyzing studies with academic medical researchers to better characterize the effects of a new compound in development, validating and piloting a new questionnaire that would be used for a new drug application, devising the first questionnaire validation analysis*



*plan (VAP) which became a departmental standard, optimizing the measurement characteristics of primary and secondary endpoint definitions for clinical trials, and study planning, simulation and prediction of program outcomes). The work I did during this time not only helped to optimize the success of several development programs but also expanded my experience and skill set. During this time, some individuals in my department often asked me, “how is the family doing?” This would have been an appropriate question if they asked it on occasion, but they asked it, repeatedly. I surmised that it was an indication of how they viewed me—as a mom but not as a serious employee. On the contrary, I felt that I was a hard-working, dedicated, and loyal employee who was contributing to the success of the organization. Fortunately, others continued to regard me with the respect they had always had and valued my contributions. I continued this part-time work arrangement for 6 years while my children were young. I eventually returned to full-time status as a program lead and have been with the company for a total of over 25 years.*

When employees have flexible work arrangements that enable them to meet both professional and personal responsibilities, it not only makes continuing to work easier/possible, it also builds employee engagement and loyalty which are good for companies. The success of these arrangements depends, in part, on their acceptance by peers. Peers who respect and help enable such arrangements not only promote diversity and inclusion but also invest in strong, long-term work relationships because while flexible-time, flexible-location, and part-time work arrangements may be for several months or even years, this often represents only a small percentage of the time that comprises an employee’s career.

Another way to show leadership as an individual statistician/contributor and help promote diversity and inclusion is to attend an event or training that is focused on an underrepresented group and afterward share what was learned with colleagues who did not attend the event. The goals of this are to: (1) become better educated about specific underrepresented groups and the difficulties they experience in the workplace, (2) pass the learning on to one’s colleagues, (3) provide a forum for discussion, and (4) expand and diversify one’s network both within and outside of one’s organization. The expansion and diversification of one’s network can also lead to new opportunities for career development.

*Ellen’s Experience: I attended the inaugural “Women in Statistics Conference” in Cary, North Carolina in May of 2014. Intrigued by an advertisement for the conference with its focus on elevating and empowering the careers of women in statistics, I and a female friend from graduate school who lived near the venue decided to attend the conference together. Not knowing what to expect, we thought it would at least be an opportunity to visit and catch up! The conference turned out to be very inspiring and informative. It was thoughtfully-planned and had a great vibe; it was noncompetitive, open and honest and focused on shared, mutual experiences. Many senior women leaders in the statistics profession from different professional sectors (academia, industry, government and consulting), and supportive men, shared their thoughts, experiences and personal stories. Some relevant professional topics included: salary negotiations, self-advocating,*

*promotion packages, managing personal and professional goals, implicit (and explicit) bias, recruiting and retention of women, disparities, and legal rights. Posters and talks on more traditional statistical research topics were also presented. The conference provided much food for thought and useful professional information, the kind that I wish I had come across earlier in my career to be able to take full advantage of the information provided. It also greatly expanded and enriched my professional network.*

*When I returned to the office, I wanted to share this experience with other women in my department, since I was the only attendee at the conference from my organization. I invited several female colleagues to lunch and asked those I invited to pass the invitation along to any others they thought might be interested in joining us. About 20 of us gathered and (although we did not realize it at the time) started to form the beginnings of a support group. Before this meeting, I had been in one-on-one conversations about career-related topics with female colleagues but had never spoken with other female colleagues in a group like this about professional development/issues. Even before I had an opportunity to share the conference content at the lunch, the conversation progressed naturally to individual experiences and challenges, and even though some of us didn't know each other very well, we shared our experiences and challenges freely and openly. We discovered we had much in common and were in a safe environment to discuss our experiences and thoughts with each other. We agreed that discussions like these were mutually beneficial and decided to keep meeting to continue the discussion. Over time, we became much closer and mutually supportive. Eventually, we even reviewed the Women in Statistics Conference program content!*

*Members of this group met weekly for lunch and/or for 30-min walks outdoors—having an opportunity to connect and get some exercise at the same time turned out to be quite popular. We sometimes brought lunch to a conference room and watched TED talks on professional development topics, many of which were identified from a list available at the inaugural Women in Statistics Conference. We also set up periodic teleconferences so colleagues from other locations could “meet” with us for a virtual lunch and join in the discussion. If someone was experiencing a difficult situation or struggling with a difficult technical statistical issue, group members offered strategies for how to handle it. We supported each other when any group member was scheduled to present at an in-house (or external) research gathering. We formed a Lean In Circle (Lean In Circles, 2019) and went through the kick-off process from which we learned even more about each other's backgrounds and career trajectories. (I was later asked by a larger women's EBRG at the company to share my group's experience with setting up a Lean In Circle; they were interested in having their members form Lean In Circles to encourage them to connect with each other on a more personal level and have a forum for open and honest discussion). Our group members encouraged each other to apply for new positions and “stretch” opportunities for which we previously may not have applied. Nearly everyone in the group went on to a new/higher-level position within the department or outside the Company.*

*Additional opportunities for professional development and for impacting diversity and inclusion in the larger statistics community resulted from forming our discussion group. One of our group members coordinated the book reviews for an industry-focused statistics journal and invited me to review the book entitled, Leadership and Women in Statistics, edited by Amanda L. Golbeck, Ingram Olkin and Yulia R. Gel. After this, another group member invited me to organize a session on leadership and women in statistics for an upcoming conference of the International Indian Statistical Association, an organization in which she had a prominent leadership role and was on the conference organizing committee. The presenters and I also did an encore session at a subsequent Women in Statistics and Data Science Conference. I invited speakers from my own organization for these sessions but also reached out to other women I did not know who had written chapters for the book. These connections expanded my professional network even further, led to the opportunity to author this book chapter with new collaborators, and has allowed us to more broadly share our knowledge and experiences related to diversity and inclusion.*

Individual contributors have a significant role to play in helping their organizations achieve and maintain a diverse and inclusive environment. They can support inclusiveness by: building relationships with all team members, reaching out to find common ground with those who have backgrounds or circumstances different from their own, and supporting colleagues who have alternative work arrangements. They can learn about unconscious bias and the difficulties faced by underrepresented groups through training opportunities and sharing what was learned with colleagues. They can also have informal discussion with individuals from underrepresented groups about professional issues and challenges or join an ERG to expand their knowledge and support. Individual contributors from underrepresented groups can expand representation and serve as role models by applying for higher-level positions when qualified. Supporting diversity and inclusion from one's vantage point as an individual contributor can effect meaningful change, from the ground up.

## **Evaluating Success and Improving Diversity and Inclusion Practices**

In order to sustain diversity and inclusion as a culture, it is critical to periodically evaluate the success of programs designed to foster it and to add programs or make improvements as needed. Benchmarking is one way to take the pulse of an organization and measure the success of its programs. Diversity Best Practices, a division of Working Mother Media, administers an annual Inclusion Index. The Inclusion Index provides data and insight into how participating organizations perform in three areas: diversity and inclusion practices in recruitment, retention, and advancement; organizational culture; and demographic transparency (Working

Mother, 2019). It is beneficial for companies to participate in the Inclusion Index to assess their inclusion practices relative to other companies. After getting the Index results, companies can develop annual objectives or focus on a set of priorities that will have an overall impact on their workplace culture and ultimately improve their ranking. For example, a follow-up action a company could take to improve recruitment outcomes is to search for candidates among organizations with a concentration of talent in underrepresented groups, such as Historically Black Colleges and Universities (HBCUs) and Hispanic-Serving Institutions (HSIs).

Another easy way to measure success is to collect feedback from employees specifically on the topic of diversity and inclusion. Due to the sensitivity of the topic, the best way to do this is usually through an anonymized survey. It should be noted that in such surveys, employees are likely to provide more honest feedback for topics that are aimed at specific practices or policies that matter to them. Results of the survey findings should be summarized and shared broadly with senior leaders and managers so they can identify actions that can be taken to address concerns that might be impacting employee engagement. For example, if the survey showed that employees were highly likely to leave the company for a better opportunity, managers could decide to conduct focus groups to better understand what factors are influencing employees' decisions to leave and how they might enhance the employee experience to improve the overall commitment to the company. If a company received candid feedback on performance management processes, the company could choose to invest in more transparent and robust rewards and recognition programs.

The Centre for Global Diversity and Inclusion is a resource for individuals and organizations who are looking to improve their diversity and inclusion practices (<http://centreforglobalinclusion.org/>). *The Global Diversity & Inclusion Benchmarks: Standards for Organizations Around the World (GDIB)* is a tool that can be used to engage with stakeholders and colleagues in a meaningful discussion on the topic of diversity and inclusion and to gain employee insights and feedback as to how to create a more diverse and inclusive workplace. There is an easy-to-use GDIB activity that is a quick assessment of the "current state" of an organization based on 14 categories covering topics such as Leadership and Accountability, Benefits, Work-Life and Flexibility, Assessment and Measurement and Social Responsibility. The best practices in each category are shown as 100% with five levels that help an organization assess progress toward the best practices for that category. The Centre Circle, a subscription offered at no cost, provides monthly updates about the GDIB and articles featuring new and innovative diversity and inclusion practices.

An important component of the feedback collection process is direct solicitation of ideas for new programs to foster diversity and inclusion. Companies and managers who solicit this type of feedback should be open to recommendations for initiatives and seriously consider the implementation of those that could have meaningful impact.

It is important for companies and managers to engage a broad range of employees in taking leadership and ownership of diversity and inclusion programs and in participating in them. It is not enough for employees within underrepresented groups

to advocate for and support each other. Advocacy and support for underrepresented groups need to cross gender, ethnic, age, and lifestyle lines. As this chapter discusses, companies, managers, and individual contributors all play very important roles in establishing and maintaining a culture of diversity and inclusion. The following is a summary of some of the specific actions we recommend that industry employees take to help build a strong culture of diversity and inclusion in their organizations:

#### Companies

- Set the tone for the importance of diversity and inclusion.
- Stay in touch with external trends in talent pools and internal progress toward appropriate representation of different groups.
- Connect with underrepresented talent pools.
- Support ERGs/BRGs.
- Survey employees and be open to new diversity and inclusion programs and changes to existing programs.

#### Managers

- Ensure criteria for hiring and promoting employees are unbiased.
- Model and reward behaviors that promote diversity and inclusion.
- Be open to the possibility that people with skills sets and styles that are different from your own can fill higher-level jobs.
- Offer and be open to flexible ways of working.
- Create an environment that discourages “covering” by showing acceptance of personal information people share.
- Encourage activities that combine the expertise of employees across demographic lines (employees of different genders, age groups, races, and lifestyle preferences).

#### Individuals

- Get to know fellow team members and find areas of commonality.
- Take the implicit bias survey and training.
- Support colleagues’ flexible work arrangements.
- Attend conferences focused on underrepresented groups and share takeaways with colleagues.
- Join an ERG or establish a new one to discuss issues related to diversity and inclusion.
- Apply for higher-level roles if you think you may be qualified.

## References

American Experiences Versus American Expectations, U.S. Equal Employment Opportunity Commission. (2015). Retrieved July 12, 2019, from [https://www.eeoc.gov/eeoc/statistics/reports/american\\_experiences/](https://www.eeoc.gov/eeoc/statistics/reports/american_experiences/).

- Boston Consulting Group. (2014). *The most innovative companies 2014: Breaking through is hard to do*. Retrieved March 3, 2020, from [https://image-src.bcg.com/Images/Most\\_Innovative\\_Companies\\_2014\\_Oct\\_2014\\_tcm9-59902.pdf](https://image-src.bcg.com/Images/Most_Innovative_Companies_2014_Oct_2014_tcm9-59902.pdf).
- Bourke, J., Dillon, B. (2016). The six signature traits of inclusive leadership: Thriving in a diverse new world. *Deloitte Insights*. Retrieved July 12, 2019, from <https://www2.deloitte.com/insights/us/en/topics/talent/six-signature-traits-of-inclusive-leadership.html>.
- Disability Inclusion. (2019). *The World Bank*. Retrieved August 9, 2019, from <https://www.worldbank.org/en/topic/disability>.
- Employee Resource Groups for Women, Fairygodboss. (2017). Retrieved August 9, 2019, from <https://fairygodboss.com/research/employee-resource-groups-women>.
- Green, J. (2016). LGBT purchasing power near \$1 trillion rivals other minorities. *Bloomberg*. Retrieved August 9, 2019, from <https://www.bloomberg.com/news/articles/2016-07-20/lgbt-purchasing-power-near-1-trillion-rivals-other-minorities>.
- Hackett, C. (2018). *Which 7 countries hold half the World's population?* Pew Research Center. Retrieved August 9, 2019, from <https://www.pewresearch.org/fact-tank/2018/07/11/world-population-day/>.
- Lean In Circles. (2019). *LEAN IN*. Retrieved November 18, 2019, from [https://leanin.org/circles?gclid=EAfAIQobChMI39ab1o\\_05QIVwZ-zCh3FQwAFEAAYASAAEgJJvPD\\_BwE](https://leanin.org/circles?gclid=EAfAIQobChMI39ab1o_05QIVwZ-zCh3FQwAFEAAYASAAEgJJvPD_BwE).
- Project Implicit. (2019). Retrieved August 9, 2019, from <https://implicit.harvard.edu/implicit/aboutus.html>.
- PwC. (2017). *The long view: How will the global economic order change by 2050?* Retrieved March 9, 2020, from <https://www.pwc.com/gx/en/world-2050/assets/pwc-the-world-in-2050-full-report-feb-2017.pdf>.
- Solomon, D. (2016). If you would consider a woman... (Chapter 26). In Golbeck, A. L., Olkin, I., & Gel, Y. R. (Eds.), *Leadership and women in statistics* (pp. 395–412). Boca Raton, FL: CRC/Taylor & Francis Group.
- Tapia, A. T. (2019). *The inclusive leader: Optimizing diversity by leveraging the power of inclusion*. Korn Ferry Institute. Retrieved from <https://focus.kornferry.com/wp-content/uploads/2015/02/The-Inclusive-Leader-Talent-Framework.pdf>.
- The Center for Global Inclusion. (2019). Retrieved August 9, 2019, from <http://centreforglobalinclusion.org/>.
- The World Bank Data. (2018). Retrieved September 19, 2019, from <https://data.worldbank.org/indicator/SP.POP.TOTL.FE.ZS>.
- Working Mother. (2019). *The 2018 diversity best practices inclusion index*. Retrieved August 9, 2019, from <https://www.workingmother.com/diversity-best-practices-inclusion-index-2018>.
- Yu, P. (2018). What should inclusion really look like in the workplace? *Forbes*. Retrieved August 9, 2019, from <https://www.forbes.com/sites/peggyyu/2018/01/17/what-should-inclusion-really-look-like-in-the-workplace/#5b0c508753f0>.

# Diversity and Inclusion in the Federal Government



Wendy L. Martinez and Donna LaLonde

**Abstract** A diverse workforce may be achieved through policy and law, but retention depends on an inclusive environment. A call for action, this chapter encourages readers to take a leadership role to ensure diversity and inclusion for government and non-profit organizations. Resources are provided for current and future leaders.

*“Our Nation derives strength from the diversity of its population and from its commitment to equal opportunity for all. We are at our best when we draw on the talents of all parts of our society, and our greatest accomplishments are achieved when diverse perspectives are brought to bear to overcome our greatest challenges.”*

President Obama, Executive Order 13583

## What Is Diversity and Inclusion?

We had a wonderful opportunity to participate in a panel session at the Women in Statistics and Data Science Conference (WSDS) 2018, where issues faced by statisticians and data scientists in the LGBTQ+ community were discussed. This panel session led to an article published in *Significance* magazine and an American Statistical Association (ASA) initiative focusing on LGBTQ+ inclusion in our profession. These opportunities enhanced our understanding of diversity and inclusion and the role leaders must play in ensuring environments that are diverse and inclusive.

---

W. L. Martinez (✉)

Bureau of Labor Statistics, Washington, DC, USA

e-mail: [martinez.wendy@bls.gov](mailto:martinez.wendy@bls.gov); [martinezw@verizon.net](mailto:martinezw@verizon.net)

D. LaLonde

American Statistical Association, Alexandria, VA, USA

e-mail: [DonnaL@amstat.org](mailto:DonnaL@amstat.org)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_10](https://doi.org/10.1007/978-3-030-60060-0_10)

Building on previous efforts to encourage diversity, a 2020 ASA initiative was originally formulated as one on diversity with a focus on the LGBTQ+ community. As we formulated the goals for this initiative we realized that diversity was a necessary first step to something more important—fostering an inclusive environment. Recognizing that individuals cannot be described by a single trait or attribute, we must challenge ourselves to acquire cultural humility and be inclusive. Environments that are inclusive are respectful, flexible, and supportive allowing members of the community to maximize their potential.

The US Office of Personnel Management (OPM) Government-wide Inclusive Diversity Strategic Plan (2016) defined diversity and inclusion and linked the two with a third term, inclusive diversity.

- *Workforce diversity* is “a collection of individual attributes that together help agencies pursue organizational objectives efficiently and effectively.”
- *Inclusion* is “a set of behaviors (culture) that encourages employees to feel valued for their unique qualities and experience a sense of belonging.”
- *Inclusive diversity* is “a set of behaviors that promote collaboration amongst a diverse group.”

As these definitions highlight, diversity is a set of attributes characterizing people, so it is passive. On the other hand, inclusion has to do with behaviors or *actions* we must take as individuals. Inclusion and inclusive diversity require action and commitment. This chapter will describe how to be a leader who fosters both diversity and inclusion.

Diversity can come in many forms—ethnicity, race, gender, sexual identity, marital status, and more. One could also say there is diversity in our disciplines and professional interests, and it is this type of diversity that we encounter most often in our work lives. Knowing how to communicate with those in other disciplines is a skill that will help throughout one’s career.

One of the authors (Wendy) has been trying for several years to get the open-source software R approved for use in the production of some statistics and models at the US Bureau of Labor Statistics. In order to do this, she has to communicate with various areas and offices of the bureau, all of which have competing interests. For example, she has been negotiating with the IT department, whose primary concerns are managing risk and ensuring software support, and the program offices, who want their employees to create innovative statistical methods for use in surveys. She has not successfully navigated this path yet to reach her goal, but she is learning new ways to communicate and negotiate at every step of the process. Perhaps, the most important one is to actively listen to the concerns of all stakeholders, to work toward consensus as a way forward, and to create a feeling of inclusion for all concerned.



## A Leader's Role in Fostering a Diverse and Inclusive Environment

*“Our Strategic Vision is to serve as the Nation’s model employer by leveraging diversity and fostering inclusion to deliver the best public service possible.”*

Vision Statement, Government-wide Inclusive Diversity Strategic Plan (2016)

For the federal government, inclusive diversity started at the top with President Obama’s Executive Order 13583 (August 2011). This established a coordinated government-wide initiative to promote diversity and inclusion in the federal workforce. The order called for all federal agencies to develop and implement strategic plans to meet the goals of the order. Agency leaders were challenged to demonstrate their commitment to inclusive diversity by promoting communication and providing innovative learning opportunities.

Executive Order 13583 was not the first one directing agencies to take steps toward greater diversity and inclusion in the federal workforce. It includes some of the prior orders as representative examples of how the nation’s largest employer is leading the way. It is worth noting that, together, these orders reflected a more comprehensive definition of diversity and did not solely focus on ethnicity.

- Executive Order 13171 (October 12, 2000) Hispanic Employment in the Federal Government: Federal departments and agencies must develop and implement programs to recruit Hispanics and to foster their career development. It also emphasized and identified best practices, which could perhaps be useful for other groups.
- Executive Order 13518 (November 9, 2009) Employment of Veterans in the Federal Government: The federal government has several initiatives for hiring veterans and their spouses, as we discuss later in this chapter. This particular Executive Order established a Veterans Employment Initiative.
- Executive Order 13548 (July 26, 2010) Increasing Employment of Individuals with Disabilities: This order directed agencies to develop recruitment strategies to hire people with disabilities and for expanding employment opportunities for them. It expanded previous orders issued in 1998 and 2000.

Executive orders from the President of the United States are one way to foster diversity and provide support for inclusion in the federal workforce. Another source of regulations and policies governing federal personnel management are actions by Congress. Most of these are derived from the Equal Employment Opportunity (EEO) Laws, the Merit System Principles, and Prohibited Personnel Practices. These are important because our approaches to achieving inclusive diversity in the federal government have to comply with this framework. See the Appendix for more information.

The federal government took steps to improve the plans and actions taken as a result of Executive Order 13583 and issued a 2016 Government-wide Inclusive Diversity Strategic Plan. This second phase takes into account lessons learned from the implementation of the initial 2011 plan. These lessons stress the need

for increased transparency of the entire human resource management process and the use of data to plan initiatives and to assess the results. The 2016 plan has the following three goals: (1) diversify the federal workforce through active engagement of the leadership, (2) include and engage everyone in the workplace, and (3) optimize inclusive diversity efforts using data-driven approaches.

The goals of the 2016 plan cannot be met without the commitment of leaders at all levels. Mandating a change in hiring practices is not sufficient for sustaining an inclusive climate. Leaders must model the behaviors that show respect for diversity, create opportunities for individuals to highlight their strengths, and establish learning opportunities to promote individual growth.

## Creating Career Opportunities for All

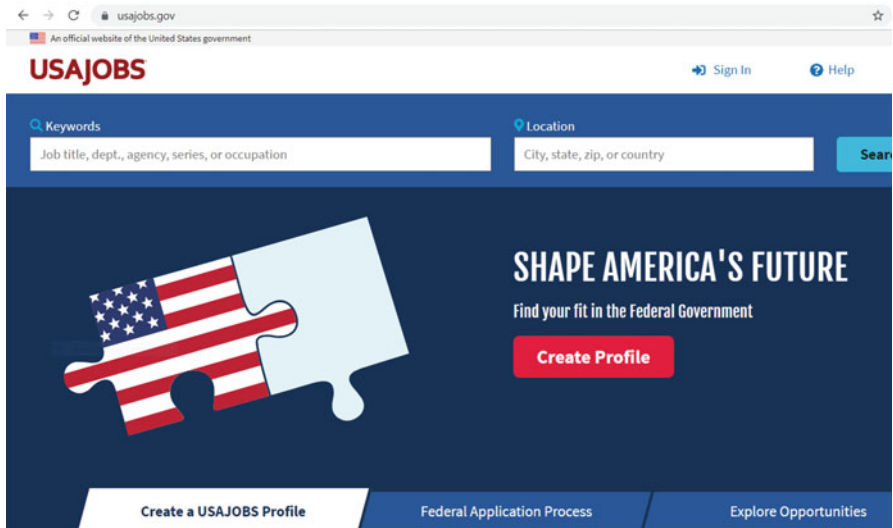
Eleanor Roosevelt said, “The future belongs to those who believe in the beauty of their dreams.” (<https://www.forbes.com/sites/jacquelynsmith/2013/01/30/30-motivational-quotes-for-job-seekers/#640346871e7f>). It is a leader’s responsibility to ensure that organizational structure supports attainment of these dreams. As we will see in this section, the US federal government is committed to leading the way to a better and more inclusive workforce.

We have been discussing the importance of having a diverse federal workforce supported by inclusive environments. In this section we focus on the starting point, hiring strategies utilized to achieve inclusive diversity. How career opportunities are announced establishes a commitment to diversity and inclusion. For those considering career opportunities with the nation’s largest employer, it demonstrates how the government is taking a leadership role in achieving inclusive diversity.

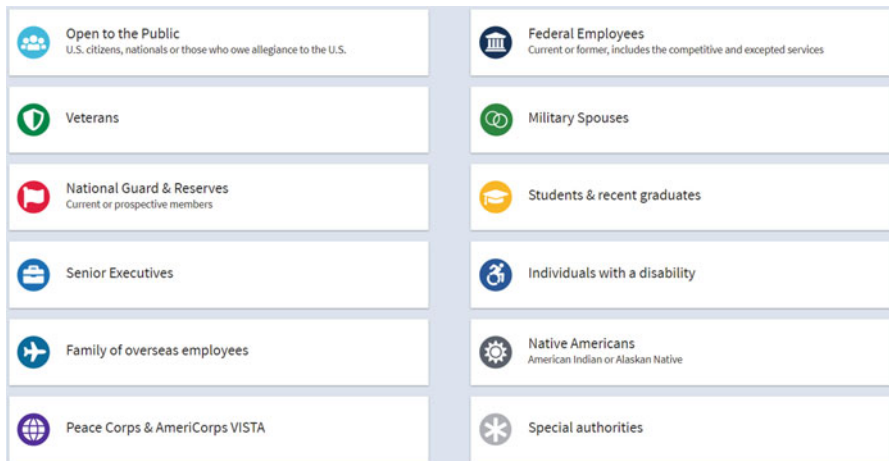
USAJOBS ([usajobs.gov](http://usajobs.gov)) is the online career resource center for the federal government. This site includes a search feature for open positions, an explanation of the hiring process, and a section highlighting special programs (see Fig. 1). The Explore Opportunities section provides a list of programs, some of which are designed to support diversity in the hiring process (see Fig. 2).

Although the federal hiring process must adhere to the laws, regulations, and principles governing personnel management in the federal government (see Appendix), leaders can impact the hiring process with the goal of building a diverse workforce. Leaders need to advocate for and support broad recruitment efforts, and they must work to reduce any bias in the hiring process.

As hiring managers, we may respond in a pro forma manner and send job postings to the usual email lists and job boards. Instead, we need to move beyond this perfunctory response and do the work to cast a wide net to include cultural groups, local ethnic community newsletters, campus interest groups, and associations or organizations serving communities of interest (e.g., women, African Americans, Hispanics, LGBTQ+, veterans, disabled persons, and others). We need to utilize all our networks, especially those associated with professional associations, to



**Fig. 1** Go to [www.usajobs.gov](http://www.usajobs.gov) to learn about all aspects of the hiring process, including how to apply for a federal job. Note the third tab at the bottom of the screen shot: Explore Opportunities. Clicking on this tab will take you to the list of special programs shown in Fig. 2



**Fig. 2** Here we see a list of special programs and hiring authorities, some of which we have already discussed

ensure a diverse applicant pool. Our commitment to proactively engaging diverse communities on federal job opportunities is key.

It is often hard to get potential candidates excited about coming to work for the government, in part because the job descriptions can be dry and full of government-speak. We should also be aware of including words in the job announcements that

might convey unconscious bias. Here are some of the changes hiring managers can take when describing government jobs.

- Focus on what a successful candidate will need to achieve in the position, rather than making applicants feel constrained by information on how it will be done. This could prevent some highly successful candidates from applying.
- Showcase the opportunities for making an impact. Early career people often want to work at exciting places where they will be doing innovative work. So, job descriptions should not use jargon, acronyms, and government specific language.
- Ask for abilities because they convey the candidate's potential and skills that can be transferred to the job.
- Highlight learning opportunities so candidates will see potential for growth.

The next step of the hiring process is the interview, and this is perhaps the place where implicit bias can have a negative impact. Here are some tips for the interview process.

- Set up a team of interviewers and establish clear guidelines for the process. This process should also be explained as much as possible with the candidates. This helps them to manage expectations and prevent misunderstandings of all parties.
- Find out if candidates have any special needs and ensure that the interview site is accessible to all. It is important to keep in mind that not all disabilities are able to be seen.
- Avoid scheduling interviews around the holy days of different religions.
- Ask all of the candidates the same set of questions, which should be relevant to the position. Be careful of how questions are asked in terms of vocabulary because words can have different meanings depending on the culture.
- Educate the interview team on best practices and strategies for reflecting on and ameliorating their biases.

The interviewer should also be cognizant of their assumptions about non-verbal communication and how these might affect their biases. For example, English might not be a person's first language or they might be taking time to think of a good answer, so silences should not necessarily be viewed in a negative light. Similarly, minimal eye contact from the candidate does not necessarily indicate lack of knowledge. The candidate's culture might view eye contact with authority figures as a sign of disrespect. Lack of eye contact could also be a result of a physical characteristic, such as a lazy eye. We know of one hiring manager who did not hire someone in large part because the candidate did not make eye contact, only to discover that the person had a physical issue with his eyes. He turned out to be an excellent researcher and would have made an excellent member of the team.

A fellow hiring manager once said: "I always seem to hire people who 'look' like me." This is an example of implicit or unconscious bias. In his book *How to Be Antiracist*, Ibram X. Kendi writes "The only way to undo racism is to constantly identify it and describe it—and then dismantle it." He makes the point that the opposite of racism is not "not racism" but rather "antiracism." We propose that this premise can be extended to any bias, so as leaders we must be committed

to identifying, describing, and ultimately dismantling bias. This hard work begins with the hiring process and continues into the workplace. One way we can address implicit bias is to acknowledge our biases and support our managers and supervisors with strategies and learning opportunities to create respectful environments.

## Diversity and Inclusion in Professional Associations

*“For organizational vitality and impact, workforce diversity is a **strategic imperative**.”*  
Association Forum, [www.associationforum.org](http://www.associationforum.org)

In the preceding section we discussed the leader’s role in ensuring diversity and inclusion in the hiring process and in the workplace. How do leaders cultivate the skills and knowledge to be effective? Many, if not most, government employees are members of associations and societies connected with their professional interests and position. The benefits of these memberships include continuing technical education, mentoring, and leadership development. Thus, we take a brief moment to explore some of the related issues and practices fostering diversity and inclusion in professional organizations.

The Association Forum ([www.associationforum.org](http://www.associationforum.org)) defines *diversity* as individual characteristics including the ones defined by OPM and listed in the Appendix. They expand the list to include color, culture, ethnicity, gender identity, physical ability, political beliefs, socio-economic status, and professional choices. They define *inclusion* as the degree in which an association welcomes and integrates members and staff throughout all aspects of the organization.

Although some practices and principles for members, staff, and volunteers of professional organizations are different from the ones outlined in the Appendix, leaders can learn from these practices and principles. The skills and knowledge acquired through these volunteer experiences will contribute to their workplace leadership. For example, associations are encouraged to provide funding for initiatives that foster and strengthen diversity and inclusion for all. These initiatives address the organization’s strategic plan, which in turn should be based on vision and mission statements. Leaders will benefit from contributing to these initiatives and will be better able to support behaviors and practices that contribute to inclusive diversity in the workplace.

The American Statistical Association (ASA) has initiatives usually spearheaded by the ASA President, all of which address the objectives outlined in the strategic plan. Past ASA Presidents with inputs from the Board have focused on specific aspects of diversity and inclusion. The ASA is styled as “The Big Tent for Statistics and Data Science,” and recent initiatives have addressed various aspects of diversity and inclusion. For example, there was a recent push to name Asians to membership on committees because their representation on the committees was not aligned with the association membership proportions. ASA leadership gathered names of qualified Asian members to serve, and new nominees were taken from this list.

Current ASA efforts are similarly focused on ensuring diversity by nominating qualified women, people of color, and LGBTQ+ persons.

We will conclude this section with a personal story to reinforce the role that professional association membership plays in leadership development. Leading a volunteer group removes the responsibility of evaluation usually associated with the work environment. We remember a conversation in a working group about the use of pronouns and our uncertainty in how to ask about a person's preferred pronoun. What was reinforced by our colleagues is that omniscience is not expected and respectful questions are appreciated. We take this and other lessons into our workplace making us more effective leaders.

## A Commitment to Lead

*"We're here for a reason. I believe a bit of the reason is to throw little torches out to lead people through the dark."*

Whoopi Goldberg

It is easy to generate statements that comply with a mandate or rule for diversity and inclusion. It is much more challenging, but also rewarding, to create environments that support inclusion. Achieving inclusive diversity is not the responsibility of just one person. It is a responsibility shared by all of us. This is easy enough to say, but what are some of the things we can do?

In the introduction we describe inclusion as requiring action. Perhaps the most important contribution we can make to inclusive diversity is to be an ally. Being an ally means taking on the responsibility to be both a supporter and an initiator. For example, we could support our nonbinary colleagues by including our preferred pronouns in our email signature. As allies, and leaders, we sometimes need to be the first to act. Being an effective ally requires knowledge and skills, so one action item for a government agency or professional association is to develop and offer ally training. Creating a respectful climate requires action by all.

Establishing and supporting affinity groups is another way we can foster inclusive diversity. They are a great way to communicate with employees about the diverse groups that make up the organization. Affinity groups can be formed at government agencies (federal, state, and local), as well as professional associations. Members of affinity groups usually have a common interest or goal. A good example of an affinity group is Blacks in Government (BIG) (<http://bignet.org/>). According to their constitution, the goal of BIG is

*"to develop a mechanism for inclusion, growth and power for all present and future Black employees in Federal, State and local governments. Therefore, we ... act as an advocate for the employment and general welfare of Blacks employed in Federal, State and local governments and to establish a national network of Black Federal, State and local government employees ..."*

We started this chapter by referencing President Obama’s Executive Order 13583 that called for agencies to establish strategic plans for inclusive diversity in their organization. We’ve already discussed ways agencies might achieve this through the hiring process. We now turn our attention and list some actions to take.

Creating an inclusive and diverse organization starts at the top. So, all senior leadership in an organization needs to embrace the ideas and communicate them to all employees. This can be done in several ways, a few of which are listed here.

- Include an objective addressing inclusive diversity in the organization’s strategic plan.
- Create a web page explaining inclusive diversity on both the inter- and intranet, so all employees can find relevant resources.
- Provide training to supervisors and human resource professionals on implicit bias and how to mitigate it.
- Provide training on inclusive diversity to new employees during their orientation.
- Create a council or committee whose mission is to ensure the organization has an inclusive environment.
- Include commitments to inclusive diversity in supervisor performance plans.
- Create inclusive diversity awards to recognize employee efforts.

## Resources for Diversity and Inclusion Ideas

We’ve described several aspects of diversity and inclusion in this chapter, and we hope that our discussion serves as a call to action. As leaders it is our responsibility to continue our own professional development and to support the professional development of our colleagues. Thus, we conclude with some online resources, so you can explore further and implement ideas in your own professional and personal environments. This is not an exhaustive list but merely a starting place to reinforce the need to be committed to active learning. These also serve as references for some of the content in this chapter.

- Department of Labor on Diversity: <https://www.dol.gov/general/jobs/commitment-to-a-diverse-workforce>
- LGBT+ Resources for Statisticians and Data Scientists: <https://www.significancemagazine.com/624>
- The Society for Diversity: [www.societyfordiversity.org](http://www.societyfordiversity.org)
- The National Diversity Council: [www.nationaldiversitycouncil.org](http://www.nationaldiversitycouncil.org)
- The Center for Association Leadership: <https://www.asaecenter.org/>
- Office of Personnel Management: [www.opm.gov](http://www.opm.gov)
- American Institute for Managing Diversity: [www.aimd.org](http://www.aimd.org)
- Association Forum: <https://www.associationforum.org/homedec>

## **Appendix: Principles, Practices, and Laws Governing Federal Employment**

All aspects of the federal government employment process are bound by many laws and principles that we outlined in this appendix. This information can be dry and some readers might not be interested in it. However, we think it is important for you to know about this regulation and policy foundation providing a diverse and inclusive workplace in the federal government. It would be difficult to have diversity without these in place. Here we describe three main areas: Equal Employment Opportunity Laws, Merit System Principles, and Prohibited Personnel Practices.

### ***Federal Equal Employment Opportunity Laws***

The Civil Rights Act of 1964 (Title VII) makes it illegal to discriminate against a person on the basis of race, color, religion, sex, or national origin (<http://www.eeoc.gov/laws/statutes/titlevii.cfm>). The CSRA also prohibits discrimination on the basis of other factors, such as marital status, political association, and sexual orientation.

The Pregnancy Discrimination Act amended Title VII makes it illegal to discriminate against a woman because of pregnancy, childbirth, or a medical condition related to pregnancy or childbirth (<http://www.eeoc.gov/laws/statutes/pregnancy.cfm>).

Title I of the Americans with Disabilities Act of 1990 (ADA) forbids discrimination against a person with a disability in private companies and state and local governments. Sections 501 and 505 of the Rehabilitation Act of 1973 cover persons with a disability in the Federal Government (<http://www.eeoc.gov/>).

The Age Discrimination in Employment Act of 1967 (ADEA) protects people who are aged 40 or older from discrimination because of age (<http://www.eeoc.gov/laws/statutes/adea.cfm>).

The Genetic Information Nondiscrimination Act of 2008 (GINA) prohibits the improper use of genetic information in health insurance and employment; bars employers from using individuals' genetic information when making a hiring, firing, job placement, or promotion decision (<http://www.eeoc.gov/laws/statutes/gina.cfm>).

The Uniform Service Employment and Reemployment Rights Act (USERRA) protects the job rights of individuals who leave employment positions to undertake military service. USERRA also forbids employers from discriminating against past and present members and applicants of the uniformed services (<http://www.dol.gov/laws/vets/programs/userra.htm>).



## ***Merit System Principles***

The Merit System Principles are a set of values by which leaders and supervisors in the federal government abide to ensure a diverse and inclusive workplace. Section 2301 (b) of Title 5 United States Code (<https://www.law.cornell.edu/uscode/text/5/2301>) states that federal personnel management will be conducted with the following:

1. Recruit qualified individuals from all segments of society and select and advance employees on the basis of merit after fair and open competition.
2. Treat employees and applicants fairly and equitably, without regard to political affiliation, race, color, national origin, sex, marital status, age, or disability condition.
3. Provide equal pay for equal work; reward excellent performance.
4. Maintain high standards of integrity, conduct, and concern for the public interest.
5. Manage employees efficiently and effectively.
6. Retain or separate employees on the basis of their performance.
7. Educate and train employees when it will result in better organizational or individual performance.
8. Protect employees from improper political influence.
9. Protect employees against reprisal for the lawful disclosure of information in “whistleblower” situations (i.e., protect who report illegal and/or wasteful activities).

## ***Prohibited Personnel Practices***

The prohibited personnel practices related to diversity and inclusion are listed below. These are taken from section 2302 (b) of Title 5 United States Code. Federal personnel management is prohibited from

1. Discriminating based on race, color, religion, sex, national origin, age, disability, marital status, or political affiliation.
2. Soliciting or considering employment recommendations based on factors other than personal knowledge or records of job-related abilities or characteristics.
3. Deceiving a person or otherwise obstructing their right to compete for employment.
4. Influencing any person to withdraw from competition for a position to improve or injure the employment prospects of any particular employee or applicant.
5. Giving unauthorized preference or advantage to any person to improve or injure the employment prospects of any other person.
6. Discriminating based on personal conduct that is not adverse to on-the-job performance of the employee, applicant, or others.
7. Violating any law, rule, or regulation which implements or directly concerns the merit principles.

# Leading and Managing Diversity in the Private Sector



Mary Batcher and Edward Mulrow

**Abstract** Modern-day managers face the task of creating effective teams of people with very different backgrounds and beliefs. Here we explore how the tasks of managing and leading are complicated by diversity.

The time is long gone when technical workplaces were filled with people of similar backgrounds and ambitions who shared a common understanding of how to interact. Now, in addition to the general challenges of management, managers face the task of creating effective teams of people with very different backgrounds and beliefs.

Leadership and management are different qualities but truly effective managers possess both to varying degrees. What do we mean by these terms and how are the tasks of managing and leading complicated by diversity? We begin with a discussion of core responsibilities of management.

## Recruiting

Recruiting is a core task that, in many environments, cannot be delegated to the Human Resources (HR) Department because the HR Department does not understand the basic technical skills needed. Even if the HR Department is able to do the initial screening, there is a possibility they will miss strong candidates who do not follow the standard paths. The challenge in sustaining diversity is to look beyond

---

M. Batcher (✉)  
BDS Data Analytics LLC, Alexandria, VA, USA  
e-mail: [marybat10@gmail.com](mailto:marybat10@gmail.com)

E. Mulrow  
NORC at The University of Chicago, Washington, DC, USA  
e-mail: [mulrow-edward@norc.org](mailto:mulrow-edward@norc.org)

the traditional large state and Ivy League universities to reach out to Historically Black Colleges and Universities (HBCUs) and smaller state universities. It may also require looking at individuals who have changed careers mid-career so, while they have work experience, they lack experience in the field and will be older entry level hires.

One should be aware that some of the HBCUs have very high standards, possibly on par with Ivy League schools. These students are heavily recruited. Firms that think they are doing the students a favor by considering them won't be successful. Assume that your competitors and other prestigious institutions want them as well, and provide them clear reasons why your firm is the best spot.

Moving outside of the standard recruiting targets carries with it a risk that the recruit will find it difficult to fit in, no matter how talented he or she is. This is especially relevant if the recruit is the initial diverse person in a very homogenous group. In that case, it is advisable to recruit multiple people from different demographics and cultural backgrounds so there is critical mass and they are not marginalized. Diversity in demographics can lead to more ideas and dynamic work teams.

In all recruiting, we need to be conscious of bias, our own and others. We are all products of our environment and have implicit bias that we may not even be aware of. A good example of such bias is the evaluation of performers for major symphony orchestras. For a long time, all orchestra members were male. Then auditions started to be held with the candidate behind a curtain and women were aware enough to not wear heels. Now, all major orchestras include both men and women. The people evaluating the applicants were presumably not explicitly biased in favor of men and thought they were being fair in their judgments.

For fairness in recruiting it is necessary for recruiters to get out of their comfort zone and consider applicants who are not like them, who did not go to the same or similar schools, do not have the same love of team sports, did not have the involvement in volunteer activities because they had to have a paying job to support themselves in school, etc.

## **Mentoring/Coaching**

When new hires start their job, they are initially treated to administrative instructions, shown their work station, and probably walked around to meet their colleagues. Maybe the new boss takes them to lunch on their first day. That is a good start but they should not just be given an assignment and left to find their way alone after that. New hires of all sorts need outreach and coaching; this is especially true of diverse hires who are trying to fit into the new and perhaps strange environment.

A peer coach or advisor can be designated to ease the transition into the new work environment. The peer coach's responsibility is to be a supporter who takes the new employee around to introduce her, takes her to lunch, helps her learn the ropes of time reporting, use of templates, and all the different aspects of office practice and procedures, includes her in informal office get-togethers, is a resource for questions

about where to go in the company for various needs, and may even advise on places to live, eat, shop, etc., although that is outside of official duties. The peer coach can be authorized to take the new employee to lunch or dinner on company expense. As appropriate, other activities can be company funded as well.

Clear expectations for the peer coach should be set and the manager should follow up to make sure the expectations are met and the relationship is working. The peer coach should be recognized through the performance review and/or cash awards. Cash awards do not have to be large to be effective. There is a chance that the new staff and the peer advisor become friends.

There may be cultural differences and language challenges when people who grew up in other cultures are hired. Difficult conversations may be needed around personal hygiene, treatment of women, jokes, and other behaviors that may not be appropriate in the office setting. In such conversations it is critical to address the behavior or conditions as inappropriate but to not diminish the individual.

Non-native English speakers may require extra attention to both written and spoken communication. Some will be good writers but will not fully comprehend the use of English article and pronouns and will need some extra editing of documents. Others may have much more difficulty expressing themselves in writing. This can create a dilemma in recruiting as candidates who excel in statistics may be quite limited in their English communication. We would like to have candidates who are fully capable in all dimensions but in reality we may need to decide whether outstanding statistical skill compensates for the extra editing time needed for an otherwise top candidate who is a non-native English speaker.

Spoken English may be a more serious hurdle, especially in a client-facing job. It is helpful to send non-Native English speakers who have trouble being understood to a class to hone their English-language pronunciation. An obstacle for improving pronunciation can be the person's lack of integration into English-speaking groups socially. Of course, that is out of a manager's control but people can be encouraged to reach out to engage with more native English speakers.

## **Assignments**

The assignments workers are given can be instrumental in their career development. Managers dealing with difficult projects are naturally inclined to go to the same workers who have previously performed well for them. This is understandable in a world of deadlines and difficult tasks. However, a balance is needed between the practicalities of the job and the responsibility to develop staff skills and help them advance their careers. Particular attention is needed in a diverse workgroup to prevent marginalizing staff who do not have the same background as the majority of staff.

So how do you get the work done on time without a lot of rework and still develop skills and careers of novice employees who may also be different from the majority? There is no perfect solution. A lot depends on the particular mix of

skills, experience, and tasks, as well as the personalities involved and the manager has to tailor the suggestions here to the particular situation.

A larger goal is to build a supportive culture so that the differences are seen as a plus, providing more insights into work problems and opportunities to learn from each other. Team building activities like brown bag lunches where staff present their work to each other and to management can be useful in promoting support for each other and for building skills. It helps if management supports the brown bags by providing pizza or sandwiches occasionally or always. In addition to brown bags, occasional team outings to celebrate successes are helpful in building a sense of unity. However it is important that each subgroup's successes are celebrated, not just those closest to management's interests or with the greatest visibility.

## **Career Planning**

It is important in promoting career development, to not project our own goals and priorities onto our staff. I have always found it important and rewarding to engage with the statistical community through attending conferences and volunteering. I learned that is not the case for everyone. I have known talented statisticians who do not find conference attendance rewarding but instead view it as an occasionally necessary burden that takes them away from their home and family. We should be respectful of the goals and priorities of our staff. It may be necessary for career advancement for them to attend conferences and engage in activities to increase their visibility but we should discuss such activities with them and recognize that they do not necessarily view them as a reward. There are multiple paths to career success and our staff often have different notions of what career success means, although most value promotions. We should have honest discussions of what it will take to be promoted and a plan to get there. In these discussions, the staff person should be required to take the lead in developing a plan and taking ownership of his or her career.

The career plan can take different forms but should include the next stage goal, a realistic timeline to achieve the goal, and the specific actions to be taken in the next few months. The plan should be revisited to assess its reasonableness and, as successes are achieved, to plan the next steps. Although the staff person owns the plan, the manager is the coach, providing feedback and encouragement, as well as participating in the planning.

We are all different, with different personalities and different backgrounds. Some individuals are very comfortable taking ownership of their careers and pushing to get the assignments and support they need. The manager should be cognizant of the differences and provide support and occasional nudges as appropriate but should not take over the planning for career advancement or the execution of the steps.

## Supervision

Managers have to provide performance reviews, counsel staff about their performance, and occasionally make decisions about retention. We tend to be most comfortable dealing with people who are like us in some way, gender, background, interests, and values. We also tend to be less comfortable with people who are different in background and values from us. Managers need to be very attentive to their inherent biases, become aware of them, and work to minimize their impact.

Although there are no easy steps to eliminate unconscious biases, it is advisable to self-monitor the treatment of staff. Ideally, managers can get to know everyone they supervise well enough to appreciate their unique strengths and weaknesses and manage to capitalize on strengths and compensate for weaknesses. It is worth noting that people are often encouraged to work on their weaknesses but the better approach is to encourage them to develop their strengths and to address the weaknesses by adjusting assignments. For example, if a person has excellent mathematical skills but is not a good writer, that person will hate working on their writing and will probably not become a strong writer. However, she will enjoy advancing her mathematical ability. She could be teamed with a good writer to develop a final product.

One situation the authors have encountered is implicit bias in managing/supervising. When called on it, the standard response is, "I would tell anyone the same thing." With enough questioning and discussion, the supervisor may be able to see that their behavior could be seen as a bias by the minority supervisee.

To counter this, senior leadership can monitor the supervisors of minority staff. One of the authors noticed that a supervisor was inadvertently micromanaging a supervisee. Office rumors about the supervisee's abilities made the supervisor scrutinize work products more. In such cases, senior leadership needs to help the supervisor understand that their inherent bias is coming out. They are not treating the supervisee like they would anyone else. We have found that once this behavior is brought to a supervisor's attention, the supervisor begins to self-monitor and the micromanaging tends to stop.

Office culture is an incredibly important contributor to the success or failure of staff. Many of us have been present when off-color or ethnic or homophobic jokes were made. We have also seen office culture in which competition was the major driver and people were isolated and not supportive of each other. The reader can probably think of other toxic situations.

Inappropriate jokes and comments can be more easily addressed by simply speaking up to make it clear that such behavior is offensive and will not be tolerated. The office culture can also be addressed through team building activities like group lunches, brown bag presentations, formal mentoring, rewarding, and publicly acknowledging teaming to arrive at solutions. If such activities fail to improve the group culture, it may be necessary to bring in outside help to work with the group. It is critical to address a toxic culture; it will not only weaken the work effort but it will also drive talent out of the group.

A painful aspect of managing people is the rare requirement to let someone go. When the work does not meet standards and the person has been given opportunities and support to improve without results, it is necessary to fire the person. This is painful for all involved but keeping someone on when the fit is not good is a disservice to the person. Letting them go to find a better fit is better for them in the long run. One of the authors experienced an instance of an employee who was eased out of the company and found a situation where the fit was better, she could succeed, and had a good career. Keeping them on can cause resentments within the work group and damage the group culture since the employees know when someone is not contributing.

When it is necessary to let an employee go, managers should consult with HR and the legal department to make sure the employee's rights are not violated. Consideration should be given to allowing the employee to resign rather than letting her go and to allowing her to spend her last time with the company working at home to seek another position. This could be the employee's vacation time. Generally, it is best to remove the employee from the office as soon as possible, even if it means paying her to find another job.

## **Conclusion**

Manager and leader tasks are difficult and are not getting any easier when we have a diverse workforce. There are definite positives in having a diversity of approaches, experiences, etc. but there are some downsides that must be considered and addressed if the company is to realize the positives.

## **Action Steps**

- Check your biases. We all have them and some are quite subtle but can influence how we assess and treat others. There are self-assessment instruments available online that can provide insight.
- Create an inclusive office culture where everyone's ideas are welcome. A diverse workforce can bring new ideas and approaches.
- Get to know your direct reports and support their career goals.
- Create opportunities to build cohesiveness in the work group. Celebratory lunches, brown bag presentations, and occasional group activities are helpful. Delegating the planning of these activities to small committees of employees gives them ownership.

# Diversity and Inclusion in Talent Acquisition



**Adrian Coles**

**Abstract** Talent acquisition is a critical business process that utilizes cross-functional teams whose members may be unaware of the broad organizational value of diversity and inclusion. We explore key opportunities within the talent acquisition process and ways to prioritize diversity and inclusion at the point of candidate selection.

## Introduction

Talent acquisition is a critical business process that organizations use to hire new employees. The process often utilizes cross-functional teams whose members may be unaware of the key considerations of talent acquisition and the value of diversity and inclusion in today's global world. Additionally, the process is often negatively impacted by individual and cultural biases that can make it ineffective at producing the ideal mix of knowledge, skills, and abilities that is necessary to help the organization stay competitive. The goal of this chapter is to help organizations recognize these opportunities and improve outcomes by leveraging the synergy between its diversity and inclusion strategy and talent acquisition process.

## *Human Capital Planning*

Our modern society is supported by numerous organizations that span key sectors such as government, academia, and private business. Each of these sectors can be further partitioned, and they provide countless products and services that help advance the human narrative. At the heart of any organization that produces a

---

A. Coles (✉)  
Eli Lilly and Company, Indianapolis, IN, USA  
e-mail: [adrian.coles@lilly.com](mailto:adrian.coles@lilly.com); [alcoes@ncsu.edu](mailto:alcoles@ncsu.edu)

© Springer Nature Switzerland AG 2021  
A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,  
[https://doi.org/10.1007/978-3-030-60060-0\\_12](https://doi.org/10.1007/978-3-030-60060-0_12)



product or service are its people, and a considerable amount of effort is invested in determining how to organize and leverage the wide range of human knowledge, skills, and abilities in producing these products and services. This effort can be broadly described as human capital planning at the societal macro-level.

At the micro-level, human capital planning identifies the needs, goals, and business objectives tied to an organization's strategy. It involves the recruitment, selection, allocation, and retention of human talent (Zula & Chermack, 2007). It is difficult to overstate the value of human capital planning in an organization's success. It is well appreciated that human expertise and experience are core components of an organization's competitive advantage. As such, human capital theorists suggest that human capital planning is a critical business process and should be a component of an organization's strategic and organizational planning (Brush & Ruse, 2005).

Talent acquisition, a key component of human capital planning, can be described as the process of finding and acquiring skilled human talent for an organization's needs. It includes the following stages: sourcing and lead generation, recruiting and attracting, interviewing and assessing, and making final selections. Some human resources (HR) professionals even suggest that hiring and onboarding is a key step of the talent acquisition process (Lybrand, 2018). Many organizations have a dedicated department that focuses on talent acquisition, and this function is usually embedded within a larger HR business unit, inclusive of a team which extends beyond human resource professionals to include hiring managers, leaders, and individual contributors.

Many statisticians and data scientists will, at some point in their career, participate in the talent acquisition process as hiring managers, interview committee members, or as lead generators (persons who identify potential candidates for organizational roles). However, it is not uncommon for professionals with little formal HR training to lack appreciation for both the key considerations of talent acquisition and the critical role diversity and inclusion (D&I) plays in any successful organization.

### ***The Business Case for Diversity and Inclusion***

Most professionals in the United States have some level of familiarity with affirmative action—the general public policy in which a person's race, color, gender, religion, national origin, disabilities, and veteran's status are considered to help increase the number and quality of opportunities offered to persons identifying as members of underrepresented groups of our society. The genesis of affirmative action can be traced back to mid-twentieth century government policies of the United States, expressed through executive orders of Presidents John F. Kennedy and Lyndon B. Johnson to help enforce the Civil Rights Act of 1964 (Graham, 1992). Currently, many private and public organizations, particularly those that desire to contract with federal agencies, also implement affirmative action programs

in their efforts to comply with federal regulations and as a component of their broader social responsibility strategy.

However, in recent years, the recognized value proposition for creating a diverse and inclusive workforce has extended beyond social equality and responsibility. This is largely due to recent research which suggests that D&I is strongly correlated with innovation and competitive advantage (Horting, 2019). A recent analysis conducted by The Wall Street Journal (WSJ) suggests that the companies ranked as the most diverse also have shares that generally outperform those of the companies ranked as the least diverse (Holger, 2019). Specifically, the analysis showed that “the 20 most diverse companies in the WSJ study had an average annual stock return of 10% over five years, versus 4.2% over five years for the 20 least-diverse companies.” (Holger, 2019).

Organizations that have embraced this value proposition have described key mechanisms through which diversity and inclusion helps them to maintain their competitive advantage. One key mechanism is that building a diverse and inclusive workforce confronts anti-innovation behaviors such as homogeneous thinking and a cultural commitment to the status quo (Beilock, 2019; Holger, 2019). Others note that establishing a value for D&I makes it easier to hire and retain talent, a concept that will be discussed in more detail later in the chapter (Chignell, 2018). Organizations that deliver products or services also note that building more diverse and inclusive teams helps them to better understand the customers they serve (Chignell, 2018).

The content of this chapter will highlight the synergy between key stages of the talent acquisition process and the business case for diversity and inclusion, which are both essential for high-performing organizations. This chapter will also explore ideas and methods to build diverse and inclusive teams of statistics and data science professionals by aligning an organization’s D&I agenda to two key steps within the talent acquisition process, attracting diverse talent and candidate assessments.

## **Attracting Diverse Talent**

### ***Know Where You Stand***

It is well established that the STEM pipeline is not well populated by persons who are members of historically underrepresented minority groups (Allen-Ramdial & Campbell, 2014). The sparsity of diverse persons in these pipelines presents an inherent challenge to many organizations desiring to realize the benefits of a diverse and inclusive culture. Further exacerbating the challenge to building diverse and inclusive teams is the fact that, in general, all professionals want to be in an organization that makes them feel valued and appreciated. An organization’s ability to accomplish this goal for all current and future team members is a function of its values and culture. As such, an initial step to attracting talent from the sparse pool of

diverse candidates in our discipline is knowing where your organization truly stands with respect to D&I.

In a 2014 survey conducted by Glassdoor, 67% of jobseekers who participated in the survey reported that a diverse workforce is important when considering a job (Diversity, 2014). Understanding that diversity within an organization attracts top talent, organizations are wise to consider some key questions. How healthy is your organization's culture? Does your organization value diversity, inclusion, and equity? Do the common behaviors within your organization demonstrate a commitment to those values? How transparent is your organization in sharing its diversity and inclusiveness?

In a similar-themed and -timed study conducted by Deloitte University's Leadership Center for Inclusion, 83% of millennials report being actively engaged when they believe the organization fosters an inclusive culture, compared to 60% when they believe the organization does not foster an inclusive culture (Smith & Turner, 2015). Considering that millennials will comprise 75% of the workforce by 2025, attracting diverse talent and creating an inclusive culture should be a priority for organizations that desire to thrive in the twenty-first century (Smith & Turner, 2015). One initial step to organizations accomplishing this goal is understanding the experience of all current employees.

### *Assessing Your Organization's Culture*

It is well established that women, members of racial and ethnic underrepresented groups, and persons with disabilities often experience negative bias in the workforce (Smith, 2002). For example, in 2016, the Society of Women Engineers (SWE) disclosed results from a study within their discipline that identified patterns of bias faced by members of these social groups in the workplace. The study revealed key patterns of overt workplace bias in the engineering profession including: prove it again bias, tightrope bias, and maternal wall bias (Williams, Li, Rincon, & Finn, 2016). Prove it again bias is the general lack of trust in the technical competency of subgroups that creates the need for members of those subgroups to prove themselves repeatedly to attain the same levels of respect and recognition as members of a dominant group. Tightrope bias is the defining of normal and acceptable behavior differently for members of a subgroup relative to a dominant group, typically more restrictively for members of the subgroup. Maternal wall bias is the general perception that persons who are parents or primary caregivers have a lower work commitment or level of competence compared to those persons who are not parents or primary caregivers. These patterns of bias are not limited to engineers; thus, it is important for your organization to assess its culture to learn if similar patterns of bias exist.

In many cases, the measurable patterns described in the SWE report are influenced by the *unconscious biases* of team members, groups, or institutions. Unconscious bias (also known as implicit bias) is a prejudice in favor of or against

a thing, person or group compared with another that results in unfair treatment towards that particular group (Unconscious Bias, 2020). These types of biases are formed beyond the limits of one's self-awareness (i.e., they exist in our blind spots), and it is important to note that *everyone has them*. Unconscious biases are especially dangerous, because they are often not aligned to one's professed values and may be difficult for individuals to accept.

There are some basic actions that an organization can take to assess its culture. First, organizations can encourage their team members to identify their unconscious biases. Again, *every team member has them*. This can be accomplished by administering implicit association tests (IATs), such as those developed and provided by Project Implicit® (Project Implicit—Social Attitudes, 2011). Their IATs cover topics that range from weight biases, religion biases, gender biases, and skin-tone biases, to name a few. Another common approach to helping team members identify their implicit biases is to conduct formal trainings on the topic. Several researchers and groups have developed resources that can be used to develop trainings on topics that range from understanding the biology of unconscious bias to minimizing the impact of unconscious biases on the talent acquisition process. For example, the Office of Diversity and Outreach at the University of California, San Francisco, has compiled a list of resources that can aid in the development of formal learning opportunities (Unconscious Bias, 2020).

In addition to helping team members identify their implicit biases, more progressive organizations are conducting internal studies to better understand the full range of their employees' experiences. In fact, the 2019 Employee Experience Report published by the TLNT—Talent Management & HR consulting group broadly defines employee experience as a combination of meaningful work, supportive management, work environment, growth opportunity, health and well-being, and trust in leadership (Laurano, Zappe, & Shick, 2019)—a definition that projects the concept well beyond those experiences typically associated with the core roles of team members. The report also shares data from the group's recent Aptitude Research Talent Survey that concluded that only 20% of companies believed employee experience was as important as customer experience, and that among those companies who identify employee experience as a priority, only 25% know where to start to improve the process (Laurano et al., 2019). This is especially problematic for today's organizations when considering that team members desire to feel valued and appreciated by their employers and that today's professionals are actively evaluating a potential organization's commitment to shared values.

Organizations such as Eli Lilly and Company—a large US-based pharmaceutical company—have put forth significant efforts to explore the shared experiences by various groups of employees to help identify the specific challenges and opportunities they bring to and encounter in the workplace (Jackson, 2018). Company leaders believe the investment in understanding each employee's journey helps to build a more diverse and inclusive workplace, which helps to fuel healthcare innovation. In addition to helping the organization achieve its mission, organizational leaders believe the prioritization of diversity and inclusion, as reflected by their investment

in conducting internal studies, has led to awards and recognition that can help them attract top talent (Jackson, 2018).

### ***Creating a Culture That Values Diversity, Inclusion, and Equity***

As noted earlier in this chapter, many organizations want to create a culture that values diversity, inclusion, and equity but do not know where to start. The previous section briefly explored the value of conducting internal studies to help assess your organization's culture. However, to fully realize the value of such exercises, organizational leadership should allow the insight gained from these studies to inform institutional policies, guidelines, and programs to help craft a culture that embraces diversity and fosters inclusion. This section explores a few ideas and best practices that can help your organization create the desired culture.

It is helpful to establish an internal D&I team to develop and advance a D&I strategy within your organization. D&I teams often include HR professionals as well as team members from other functional areas, and they typically model the culture that the organization aims to achieve. These teams are often led and sponsored by an executive or senior leader within the organization. This sponsorship helps to convey the seriousness of the D&I agenda and to hold leaders throughout the organization accountable for progress. In addition, these teams often serve as a primary communication channel between employees and senior leaders, further helping to inform policies, guidelines, and programs.

The organization should consider the value of D&I messaging. It is difficult to overstate the value that polished messaging has in one's effort to create a diverse and inclusive culture. The crafting of the organization's message can be partly accomplished by the D&I team and should be communicated by senior leaders to convey the importance of its content. There are at least three platforms well suited for delivering your organization's message.

First, the organization's stance on D&I can be emphasized through formal trainings on the topic or embedded within other training experiences. Second, the organization's value for D&I can be emphasized during all phases of the performance management process: goal setting, mid-year performance reviews, and other coaching sessions. Last, the organization's commitment to D&I can be emphasized through well-timed memos that correspond with heritage month celebrations, such as Hispanic Heritage Month, as well as other annual and biannual cultural celebrations, such as Chinese New Year celebrations.

Another best practice to creating a culture that values diversity and inclusion is to create employee resource groups. Employee resource groups provide support, advocacy, education, and mentoring to groups such as women, racial and ethnic groups, groups defined by generation (e.g., early career professionals), military veterans, people with disabilities, and members of the LGBTQ community. These groups are typically informal and focus on business or professional development issues (Moran, 2017). Effective employee resource groups are inclusive, i.e.,

membership expands beyond those who are representatives of the core group. This inclusiveness leads to an increase in cultural awareness and further helps advance the organization towards its D&I goals.

In addition to these best practices, many organizations that hold D&I in high regard have established performance markers for this business imperative. The rationale for this trend is that there are few business imperatives that do not have clear and measurable goals to help assess progress and achievement; D&I should be no different. After establishing their performance markers for D&I, some organizations hold themselves accountable by publicly communicating their progress. For example, in 2016, Intel Corporation—a large US-based technology company—established the goal to reach full representation of women and minorities in its US workforce by 2020, and it publicly disclosed its progress towards this goal in each subsequently released annual diversity and inclusion report (Intel Releases, 2016). Although this trend is gaining momentum, organizations that plan to establish D&I performance markers should seek legal counsel to ensure no laws are violated during the process.

### ***Promoting Your Culture and Reaching Your Target Audience***

Earlier in this chapter, it was noted that the STEM pipeline remains poorly populated by persons from historically underrepresented groups. The lower number of available candidates from these minority groups, relative to majority groups, translates to fewer candidates from these select subgroups having an awareness of what your organization has to offer. This means that if your organization is serious about increasing diversity among its workforce, significant effort must be made to expose professionals from underrepresented groups to the opportunities within your organization and the healthy culture that it has worked hard to create.

One recommended approach to successfully reaching your target audiences is to implement *diversity segmented recruiting* (Sullivan, 2015). The idea is borrowed from diversity product marketing, and it requires organizations to use internal data to identify critical subgroups to target. It also encourages the development of marketing materials and recruiting strategies that address the unique expectations of each critical subgroup (Sullivan, 2015). The extension is natural from the perspective that each organization is selling themselves to top candidates just as much as candidates are selling themselves to organizations.

Another approach to reaching candidates in your target audience is to offer diversity referral bonuses as a component of your overall D&I strategy. In general, it is not uncommon for organizations to offer higher referral bonuses for referring persons to critical or hard-to-fill roles, and some experts argue that employee referrals produce the highest quality and the highest volume of hires (Sullivan & Do, 2015). Companies that define D&I as a business imperative simply extend the idea to diversity recruiting. For example, in 2014, Intel Corporation observed that women comprised less than 20% of their US-based workforce. In a highly

publicized show of commitment to their D&I agenda, the company doubled their employee referral bonus for new hires from underrepresented groups—women, people of color, and veterans to help meet their D&I goals (Bhattacharya, 2015). In 2019, women comprised as much as 27% of their US-based workforce, with similar improvements in other underrepresented groups. This progress may have been in part influenced by their referral bonus strategy.

Another way to reach your targeted audience is to identify, support, and establish a presence at events and places where members of your targeted audience go to be informed and to receive various types of support. Participants of these organized activities are seeking to understand and connect to the breadth of available opportunities in our discipline. Establishing an enduring relationship between your organization and event organizers can yield huge returns in diversity recruiting.

There are several annual events that target diverse audiences of statisticians and data scientists. For example, committees within the American Statistical Association (ASA) organize several events that serve women and historically underrepresented minority groups. Its Committee for Minorities in Statistics organizes the annual Diversity Mentoring Program, a multiday program that brings together early-career professionals with more senior professionals to provide mentoring and career development. This committee also organizes StatFest, a one-day conference that aims to expose undergraduate students to a broad range of career options in statistics and data science. The Caucus for Women in Statistics and the ASA Committee on Women in Statistics organize the annual Women in Statistics and Data Science Conference. Other professional organizations and groups organize events that may also serve as well-established pipelines for diverse talent, such as the Field of Dreams Conference organized by the Math Alliance, the ENAR Diversity Workshop organized by the International Biometric Society's Eastern North American Region, and the National Diversity in STEM Conference organized by the Society for Advancement of Chicanos/Hispanics and Native Americans in Science.

In addition to establishing a physical presence at key events, organizations successful at diversity recruiting also invest in digital marketing. The basic steps of digital marketing are similar to those as conventional marketing: attract, engage, nurture, invite, and convert (Payne, 2017). For the purpose of diversity recruiting, each step is tailored to diverse groups. Organizations should consider establishing a presence on multiple social media platforms and job boards to increase their chances of attracting a diverse set of candidates. Content on these platforms should be engaging, relevant to the targeted audiences, and encourage prospect feedback. To further extract value from your tailored digital marketing efforts, relationships that are initiated through social media platforms can be further nurtured by email communications and face-to-face meetings at organized events (Payne, 2017). This extra step communicates a commitment to D&I-related values. In doing so, organizations can move prospects from being persons who are unaware of their organizations to those who are eager to learn more about them.



## Interviewing and Selection

### *Objective Screening and Interviewing*

Employment interviews are the primary instrument used by most organizations to select future team members. It is, at its most fundamental level, a social interaction between an employment candidate and an interviewer (or a group of interviewers). As such, understanding how social and psychological factors influence the conduct and outcome of interviews has been the topic of much research (Harris, 1989; Phillips & Dipboye, 1989; Posthuma, Morgeson, & Campion, 2006). This section will share some barriers to objective screening and interviewing and approaches to overcome these barriers.

Several well-studied patterns of thought and behavior are known to be barriers to fair and objective interviews. For example, several groups have studied and commented on the role stereotypes and expectations play in employment interviews (Posthuma et al., 2006). It has been noted that interviewers often have their own cognitive impressions about ideal candidates and that these cognitive schemas are often related to demographic characteristics of the candidate (Posthuma et al., 2006; Wheeler, 2017). Without intervention, these impressions can be durable, as it has even been observed that these stereotypes may follow interviewers across organizations—informing hiring decisions at an interviewer’s current organization in a manner that fails to reflect the current organization’s values and business priorities (Rynes & Gerhart, 1990).

Another barrier to objective interviews is confirmation bias. It is our tendency to seek out information to support our hypotheses (i.e., our stereotypes and expectations) (Posthuma et al., 2006). One way that confirmation bias may present itself during the interview process is in the selection of questions and the interpretation of candidate responses. In these instances, questions may be consciously, *or unconsciously*, tailored to prove one’s position such that they do not adequately reflect the role (Posthuma et al., 2006). Confirmation bias may also present itself during reference checking. Interviewers may use this step of the candidate assessment process only to reaffirm their decision as opposed to truth-seeking (Lermusi, 2013). This type of bias is especially problematic when there is a supposed rationale for the stereotype, such as poorly analyzed and/or interpreted data on the performance of members of specific groups. For example, the once held belief that mathematical achievement is influenced by genetics may lead interviewers to be biased towards Asian candidates when research has concluded that genetics alone does not determine achievement (Uttal, 1997).

Another unhealthy pattern of behavior closely related to stereotypes is the tendency to favor candidates who share traits with the interviewer, i.e., interviewer–applicant similarity bias (Posthuma et al., 2006). Researchers have studied how similarity in such things as attitudes, race, and sex might influence interview processes and outcomes. Studies in this area have found that candidate sex similarity resulted in interviewers asking more positive questions to those of the same sex,



and other studies have concluded that racial similarity was related to higher ratings of candidates (Harris, 1989; Schmitt, 1976). It is generally accepted in this body of literature that the demographic similarity of interviewers and candidates tend to have varying levels of observed effects on the ratings of candidates (Posthuma et al., 2006). While it is likely that interviews will always have some level of subjectivity, approaches have been advanced to help make the interviewing process more objective.

One well-accepted approach to conducting fair and balanced interviews is to use a diverse interview team and to ensure that each team member has a meaningful voice in selection decisions (Konrad, 2012). This approach is valuable, because each interviewer has personal biases. Those biases may be triggered by some of the candidate's non-job-related characteristics, such as handshakes, eye contact, tattoos, and body language to name a few. In these instances, another member of the interview team may be able to explain those concerns as cultural differences that do not relate to future performance in the role. Another benefit of this approach is the demonstration of your organization's commitment to D&I early in the relationship with a potential team member. This benefit is attractive in an era where job candidates prioritize an organization's commitment to D&I in their selection process.

Another well-established approach is to conduct structured interviews. Ideas to help make interviews more structured include predetermining processes for recording observations during the interview and structured criteria for making decisions at the conclusion of the interview (Ducey, 2019). Tools such as interview score sheets can reduce an interviewer's use of non-job-related factors as the basis for candidate ratings (Sullivan, 2017). Score sheets also make it easy to predetermine how responses to each question should be classified. Another popular structured process is the use of a validated question bank that includes only job-related questions (Sullivan, 2017; Wheeler, 2017).

In addition to developing a structured interview process, organizations are wise to pay special attention to the structure of the questions asked during the interview. Many organizations have adopted the use of job-related behavioral questions (backward-looking) to help determine whether the person has the necessary skillset to perform well in the role (Williams, 2006). Behavioral questions require candidates to self-reflect and share real experiences. They allow interviewers to map the candidate's previous experiences to the expectations of the role. However, it is not clear that past behavior is always the best predictor of future behavior. This is because behavioral predictability depends on multiple factors such as recency, job-relatedness, and candidate recall (Williams, 2006). Situational questions (forward-looking) are another type of question that can be objectively integrated into an organization's question bank (Fall, 2012). Situational questions require candidates to think about situations they will likely face. They allow interviewers to assess other important skills such as critical thinking, learning agility and problem solving.

## Summary

The talent acquisition process is a critical business process that allows organizations to obtain team members that can help them succeed. The process utilizes cross-functional teams whose members may not be familiar with the key considerations of talent acquisition and the value of diversity and inclusion in today's global world. The process is often negatively impacted by team member and cultural biases; and thus, rendered ineffective at producing the ideal mix of personal experiences and perspectives that are necessary to help your organization stay competitive in diverse marketplaces and professional sectors. While such biases can negatively impact the talent acquisition process at each stage, they have been frequently observed to negatively impact organizations' ability to recruit and attract diverse talent and their efforts to fairly assess candidates.

These challenges to the talent acquisition process are not without solutions. The high-level action plan below is one solution. It can help an organization marry together its overall talent acquisition strategy with its diversity and inclusion agenda.

### High-Level Action Plan to Acquire Diverse Talent

1. Assess your organization's culture.
2. Create (or maintain) a culture that values a diverse and inclusive workforce.
3. Intentionally source talent from pools of diverse candidates.
4. Engage candidates from targeted audiences in a meaningful and timely manner.
5. Objectively screen and assess candidate qualifications.
6. Use a fair and balanced system to rank candidates and make final selections.

Each step within this high-level action plan requires a significant level of effort. However, thoughtful implementation of this action plan can help your organization maintain its competitive edge and demonstrate a high level of social responsibility by building diverse and inclusive teams of statistics and data science professionals.

## References

- Allen-Ramdial, S.-A. A., & Campbell, A. G. (2014). Reimagining the pipeline: Advancing STEM diversity, persistence, and success. *BioScience*, 64(7), 612–618.
- Beilock, S. (2019). *How diverse teams produce better outcomes*. New York: Forbes.
- Bhattacharya, A. (2015). *Intel doubles bonus for referring women and minorities*. CNN Tech 2015 [cited 2019]. Retrieved from <https://money.cnn.com/2015/08/04/technology/intel-minority-referral-bonuses/index.html>.
- Brush, M. C., & Ruse, D. H. (2005). Driving strategic success through human capital planning: how Corning links business and HR strategy to improve the value and impact of its HR function. *Human Resource Planning*, 28, 49–60.
- Chignell, B. (2018). *Five reasons why diversity and inclusion at work matters*. Marlow: CIPHR.
- Diversity. (2014). What job seekers really think about your diversity and inclusion stats [cited 2019]. Retrieved from <https://www.glassdoor.com/employers/blog/diversity/>.

- Ducey, W. (2019). *Why structured interviews are the best way to hire*. New York: ERE Recruiting Intelligence.
- Fall, G. (2012). *Interviewing for critical-thinking ability*. New York: ERE Recruiting Intelligence.
- Graham, H. D. (1992). The origins of affirmative action: Civil rights and the regulatory state. *The Annals of the American Academy of Political and Social Science*, 523(1), 50–62.
- Harris, M. M. (1989). Reconsidering the employment interview: A review of recent literature and suggestions for future research. *Personnel Psychology*, 42, 691–726.
- Holger, D. (2019). The business case for more diversity. *The Wall Street Journal*.
- Horting, K. (2019). *The business case for diversity and inclusion*. New York: Forbes.
- Intel Releases. (2016). *Diversity and inclusion annual report*. [cited 2019]. Retrieved from <https://newsroom.intel.com/news/intel-releases-2016-diversity-inclusion-annual-report/#gs.1f574n>.
- Jackson, A. E. (2018). *What led to Eli Lilly's best places to work win? One word—Diversity*. Companies Hiring. [Glassdoor.com](https://www.glassdoor.com).
- Konrad, A. (2012). Leveraging workplace diversity in organizations. *Organizational Management Journal*, 3(3), 164–189.
- Laurano, M., Zappe, J., & Shick J. (2019). *The new employee experience and the difference it makes*. [TLNT.com](https://www.tlnt.com).
- Lermusi, Y. (2013). *Confirmation bias can get in the way of smart hiring decisions*. New York: ERE Recruiting Intelligence.
- Lybrand, S. (2018). *What is talent acquisition?* Retrieved from <https://business.linkedin.com/talent-solutions/blog/recruiting-tips/2018/what-is-talent-acquisition>.
- Moran, G. (2017). *How top companies are getting inclusion right*. New York: Fast Company.
- Payne, J. (2017). *Digital marketing leads the next generation of talent acquisition*. New York: ERE Recruiting Intelligence.
- Phillips, A. P., & Dipboye, R. L. (1989). Correlational tests of predictions from a process model of the interview. *Journal of Applied Psychology*, 74, 41–52.
- Posthuma, R. A., Morgeson, F. P., & Campion, M. A. (2006). Beyond employment interview validity: A comprehensive narrative review of recent research and trends OVER time. *Personnel Psychology*, 55(1), 1–81.
- Project Implicit—Social Attitudes. (2011). [cited 2019]. Retrieved from <https://implicit.harvard.edu/implicit/takeatest.html>.
- Rynes, S., & Gerhart, B. (1990). Interviewer assessments of applicant fit: An exploratory investigation. *Personnel Psychology*, 43, 13–35.
- Schmitt, N. (1976). Social and situational determinants of interview decisions: Implications for the employment interview. *Personnel Psychology*, 29, 79–101.
- Smith, R. A. (2002). Race, gender, and authority in the workplace: Theory and research. *Annual Review of Sociology*, 28, 509–542.
- Smith, C., & Turner, S. (2015). *The radical transformation of diversity and inclusion—The millennial influence*. L. Deloitte Development, Editor. Deloitte University—The Leadership Center for Inclusion.
- Sullivan, J. (2015). *Diversity recruiting fails when you lump all diverse groups together*. New York: ERE Recruiting Intelligence.
- Sullivan, J. (2017). *The definitive action guide for minimizing bias and increasing diversity hires (part 2 of 2)*. New York: ERE Recruiting Intelligence.
- Sullivan, J., & Do, K. N. (2015). *Instantly improve diversity recruiting results with a bonus for diversity referrals*. New York: ERE Recruiting Intelligence.
- Unconscious Bias. (2020). Retrieved from <https://diversity.ucsf.edu/resources/unconscious-bias>.
- Uttal, D. (1997). Beliefs about genetic influences on mathematics achievement: A cross-cultural comparison. *Genetica*, 99, 165–172.
- Wheeler, K. (2017). *Predictive analytics, bias, and interviewing*. New York: ERE Recruiting Intelligence.
- Williams, W. (2006). *Behavioral interviewing can be accurate, but only when done right*. New York: ERE Recruiting Intelligence.

Williams, J. C., Li, S., Rincon, R., & Finn, P. (2016). *Climate control: Gender and racial bias in engineering?* Chicago, IL: Society of Women Engineers.

Zula, K. J., & Chermack, T. J. (2007). Integrative literature review: Human capital planning: A review of literature and implications for human resource development. *Human Resource Development Review, 6*(3), 245–262.

**Part V**  
**Organizing Within Academe**

# Leadership and Diversity in Statistics: Great Initiatives by Faculty Advocates



Marcia Gumpertz and Jacqueline M. Hughes-Oliver

**Abstract** This chapter describes several high-impact and enduring diversity efforts initiated by or in connection with Statistics faculty: NC State's GLBT Center and Faculty Salary Equity Study, the Joint Statistical Meetings Diversity Mentoring Program, the National Alliance for Doctoral Studies in the Mathematical Sciences (the Math Alliance), and StatFest.

Three important ideas underlie most of the diversity initiatives described in this chapter. The first is that diversity efforts have to be led by people in units throughout an organization or a discipline. Diversity and inclusion initiatives can't be seen to be the property or responsibility of one entity, but must be the responsibility of all. In order for diversity efforts to take hold and be meaningful, people throughout the organization must be engaged and must own the efforts. This was a guiding principle of NC State's Office for Diversity and Inclusion, led by Vice Provost Jose Picart. Thus, many efforts of the office involved bringing campus community members together, building structures and platforms to encourage, assist and implement initiatives by faculty, staff, and students, and equipping campus community members to lead diversity efforts. Substantial time was devoted to assembling and meeting with affinity groups, task forces, College and University diversity committees, department heads, and other campus leaders and search committees. Several of the initiatives reported in this chapter came about through this process.

The second and third ideas are complementary to the first and came to us from working with Mary Wyer, associate professor of Psychology at NC State. The second idea is that, for changing the way individuals think about issues, the most influential people are trusted and respected colleagues and friends. Ideas spread from one individual to another; hence, engaging and training groups of people embedded in different departments and units are an effective way to spread ideas.

---

M. Gumpertz (✉) · J. M. Hughes-Oliver  
Department of Statistics, North Carolina State University, Raleigh, NC, USA  
e-mail: [gumpertz@ncsu.edu](mailto:gumpertz@ncsu.edu); [hughesol@ncsu.edu](mailto:hughesol@ncsu.edu)

All of these individuals will have different spheres of influence. If you want to reach faculty, then faculty colleagues are the most trusted and respected change agents. If you want to reach faculty in a particular discipline, then other faculty in the same discipline are the most effective, because they understand the norms and culture within that discipline.

The third idea is to engage and educate current and future leaders about the need for the various diversity efforts, how they can use their positions to promote diversity and inclusion and why it might be advantageous to do so. Institutional leaders have a platform from which they can provide social validation for faculty, staff, and student diversity efforts. They may be able to provide incentives that encourage different types of activities. They may be able to enact changes in policies or practices and they may have the resources to fund initiatives. If the leaders of the institution are passionate about diversity, they will bring this passion to their leadership roles. Developing a diverse pool of future leaders can yield amazing change in a surprisingly short amount of time.

The next sections describe several diversity initiatives built by individuals at NC State and other universities that have had profound impact on the institution or the discipline. All of the initiatives have some connection to Statistics, through either the main proponents or through the use of statistics to build the case for change or to implement the initiative.

## **NC State GLBT Center**

The NC State GLBT Center is one of the most enduring and visible manifestations of action by individuals at NC State. The Center was proposed by the GLBT Subcommittee of the University Diversity Advisory Committee in 2006. Three statisticians or future statisticians served on this subcommittee: Dan Solomon, Dean of the College of Physical and Mathematical Sciences and former Head of the Department of Statistics, Bill Swallow, Professor of Statistics and Sam Morris, who went on to earn a PhD in Statistics and is now a data scientist at Google. The committee thought that a GLBT center would be a real plus for the campus, and at one of the meetings, Bill Swallow offered to write a definite proposal, which he then did. The proposal for the Center relied heavily on data from a 2004 student diversity climate survey. That survey showed that substantial fractions of the gay, lesbian, bisexual, and transgender students did not feel accepted and experienced a hostile learning environment. A few of the results from the 2004 survey are reproduced in Table 1.

Bill Swallow shepherded the proposal through channels, meeting with the Chancellor, Provost, and Vice-Chancellor for Student Affairs, individually, and then with the Faculty Senate, Student Senate, and the Associate Deans. There was unanimous support from all the faculty and administration people and a good majority in the Student Senate, but there was also vocal opposition from some students, with online groups formed to vent. The tipping point came in December

**Table 1** Selected Results\* from 2004 NC State Student Diversity Climate Survey (extracted from <https://report.oirp.ncsu.edu/Survey/reports/climate/ccindex.htm>)

<i>Feel like you belong at NC State? (%)</i>				
	Undergraduates		Graduate students	
	Seldom/never	Always/usually	Seldom/never	Always/usually
Heterosexual	4.2	80.8	7.9	74.3
GLB	9.1	59.6	18.2	58.2
<i>Feel physically threatened at NC State? (%)</i>				
	Undergraduates		Graduate students	
	Seldom/never	Sometimes	Seldom/never	Sometimes
Heterosexual	94.6	4.5	94.4	4.8
GLB	84.8	14.1	87.5	12.7
<i>Sometimes faculty make inappropriate jokes/comments about different others (%)</i>				
	Undergraduates		Graduate students	
	Disagree/disagree strongly	Agree/agree strongly	Disagree/disagree strongly	Agree/agree strongly
Heterosexual	73.5	10.5	74.4	12.2
GLB	58.6	24.2	58.2	32.7

*\*Note that the response categories for the first two questions were “Never,” “Seldom,” “Sometimes,” “Usually,” and “Always.” These have been collapsed in the table above, and the “Sometimes” category has been omitted. Similarly, the response categories for the third question have been collapsed from “Disagree Strongly,” “Disagree,” “Neither agree nor disagree,” “Agree,” and “Agree Strongly” and the percent of “Neither agree nor disagree” responses have been omitted from the table*

2006 when the student government held a town hall on the issue of creating an LGBT Center. At this meeting, where a panel of administrators from Student Affairs, the Office for Diversity and African American Affairs, and the Counseling Center fielded questions, some students in the audience made very angry and hateful comments and applauded when they heard that LGBT youth have higher rates of suicide. The provost was in the audience, and in January 2007, the provost and the vice-chancellor of student affairs committed to creating a GLBT Center.

NC State was only the second university in the University of North Carolina system to open a center devoted to the needs of lesbian, gay, and transgender students, faculty, and staff. NC State’s GLBT Center provides a physical space for students and is always packed. The Center palpably changed the atmosphere for the GLBT community. Today, the Center enjoys wide support across campus. In the 2015 Campus Climate Survey, 57% of gay, lesbian, and bisexual and 26% of heterosexual undergraduates reported that they are “Definitely” or “Very Likely” to use the GLBT Center. The Center provides support and advocates for GLBT students so they can flourish at NC State. It has also become a leading champion across the campus and in the community of social justice for people of all identities (Fig. 1).





Fig. 1 NC State GLBT Center, July 2019

## Parental Leave for Graduate Students

Two statistics faculty, Pam Arroyo and Montse Fuentes, led the effort to create a policy providing parental leave for graduate students at NC State. In early 2010, Pam Arroyo took the lead on studying this issue and advocating for parental leave for graduate students when she served as a representative to NC State's Council on the Status of Women and as co-director of the graduate programs in Statistics. The initiative faced slow going at first but picked up endorsements and became an official NC State Regulation on May 1, 2012.

The Council on the Status of Women first researched what other universities were doing and found that our neighbor UNC-Chapel Hill already had in place a policy that we could use as a model. The UNC-Chapel Hill policy provided 6 weeks of leave for one parent during which the student continued to be enrolled and received benefits and a full stipend if they were on a teaching or research assistantship or fellowship. The student also was granted a one-semester extension for all academic responsibilities. Pam had several conversations with the dean of the Graduate School about the possibility of providing parental leave for graduate students. Paying for the program seemed to be a large obstacle, but there was interest in trying to find a way to make it happen.

From 2008 to 2012, NC State had an NSF ADVANCE grant for promoting the careers of female faculty in the sciences and engineering. The project was called Developing Diverse Departments (D3), and the central feature of the D3 project was a corps of faculty advocates called ADVANCE Scholars. Two statisticians, PI Marcia Gumpertz and co-PI Dan Solomon, were part of the D3 leadership team. Montse Fuentes, a professor of Statistics, participated in this project as an ADVANCE Scholar and took on advocating for parental leave, modified duties for faculty with family responsibilities, and child care as her initiatives. In November 2010, without knowing about the Council on the Status of Women's efforts on parental leave for graduate students, Montse made a presentation about several issues affecting parents and families, including the need for parental leave for graduate students, to the department heads and deans of the College of Physical and Mathematical Sciences.

After this presentation to the College of Physical and Mathematical Sciences department heads and deans and another presentation in January 2011 by Pam Arroyaw and Montse Fuentes, specifically about the need for parental leave for graduate students, the dean and department heads in the College decided to arrange for parental leave for graduate students as appropriate to the specific case. If funding was the limiting issue, the Dean's Office agreed to step in to help. In July 2011, Montse Fuentes became Head of the Department of Statistics and one of her first actions was to start an investigation into what would be involved in creating a departmental policy on family leave for students.

Montse also served on the Faculty Senate and there she introduced a resolution recommending that NC State adopt UNC-Chapel Hill's Graduate Student Parental Leave Policy to allow graduate students to have 6 weeks of leave, to extend the clock one semester, and to be able to remain on health insurance. That resolution was adopted by the Faculty Senate in November 2011. The provost agreed to move forward with the policy if it gained the support of the Student Government in addition to the Faculty Senate. The Student Senate also adopted a resolution in support of an enhanced graduate student parental leave policy and NC State created an official Regulation on Parental Leave for Graduate Students that went into effect in May 2012.

Anecdotally, in the period before the policy was enacted two graduate students in Statistics had complicated C-sections. They had no support from the university and found it very difficult. One was an international student and would have lost her visa status if she stopped out for a semester. She stayed with the program, but was very ill for a period of time and it was a struggle to keep up her doctoral work. The other student ended up dropping out of the doctoral program. Since NC State's Regulation on Parental Leave for Graduate Students was enacted, four female students in Statistics have used parental leave and all four have successfully completed their PhDs.

## Faculty Salary Equity Study

In the early 1980s, the Advisory Council for Women's Affairs at NC State requested the first faculty salary equity study at NC State. Rebecca Leonard, associate professor of Communication, was involved in initiating the study, and Jackie Dietz, professor of Statistics, was heavily involved in conducting the salary equity study, which was administered annually from 1982 to 1999. In 2000, the University hired an outside consultant to conduct the salary equity study and has conducted it on roughly a three-year cycle since then.

Two models were fit to the salary data in the early years, one including faculty rank and one excluding faculty rank:

1.  $y_{ijkl} = \mu + A_i + B_j + C_k + \beta_1 x_{1ijkl} + \beta_2 x_{2ijkl} + \varepsilon_{ijkl}$
2.  $y_{ijklm} = \mu + A_i + B_j + C_k + D_l + \beta_1 x_{1ijklm} + \beta_2 x_{2ijklm} + \varepsilon_{ijklm}$

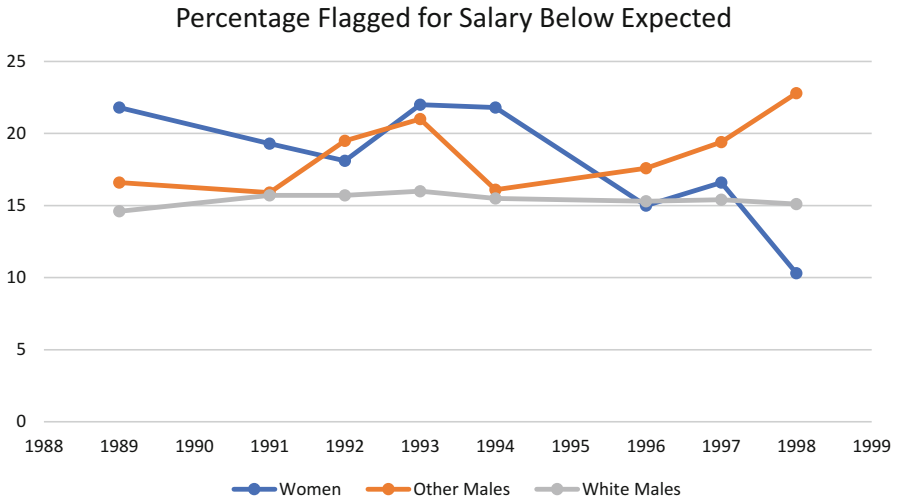
where  $A_i$  is the effect of the highest degree (doctorate, professional, masters, bachelors, other),  $B_j$  is the effect of a 9-month or a 12-month contract,  $C_k$  is the effect of a visiting position (yes or no), and  $D_l$  is the effect of faculty rank (named professor, full professor, associate professor, assistant professor, instructor, or lecturer);  $x_1$  represents the year of degree and  $x_2$  represents the year of hire. Separate equations were fit for each academic college.

University administration preferred to use model (2), the model that includes faculty rank as a predictor variable, because it explains more of the variation in salary than model (1), the model without faculty rank. The American Association of University Professors (AAUP), on the other hand, recommended using model (1) because of the possibility that the same factors that affect salary may also affect an individual's time to promotion, particularly if the same individual, e.g., the department head, is responsible for setting salaries and for summarizing the department's recommendations for promotion. The issue is that if an individual is kept in a lower rank for a long time, their salary may appear high for faculty of that rank, but if they had been promoted to a higher rank, that same salary would appear to be low for the higher rank. Thus, including faculty rank in the regression model may mask or confuse some of the effects of gender or race on salary.

The methods used were based on recommendations by the AAUP in the Higher Education Salary Evaluation Kit (Scott, 1977). The author of this Kit, Elizabeth Scott, was a well-known UC Berkeley statistician. The Committee of Presidents of Statistical Societies (COPSS) presents an award biennially in her name, the Elizabeth L. Scott Award for "fostering opportunities in statistics for women," which is awarded to recognize an individual who exemplifies Scott's efforts to promote the careers of women in academia.

The regression models were fit to salary data for full-time white male teaching faculty not on leave or having administrative or special titles. The fitted models were then used to predict the salaries for women and other non-white male faculty. Faculty for whom the actual salary was substantially lower than that predicted for white males were flagged for individual review. Lists of flagged faculty were provided to the provost, and the fitted models were freely available to faculty so they could compute their own predicted values. The difference between the actual salary and the predicted salary was called the residual. The 15th percentile of the residuals for white male faculty was used as the cutoff value for flagging faculty with low salaries, so by definition, 15% of white male faculty were flagged. The percentage of women flagged for low salaries decreased from 25% in 1987–88, the first year for which data are available, to 10% in 1998, the last year for which flagging was done (Fig. 2). On the other hand, the percentage of other males with low salaries fluctuated and rose to 23% by the end of this time period.

In 2001, NC State commissioned an external consultant, Haignere, Inc., to conduct a salary equity study to "diagnose whether or not systemic gender and race faculty salary differences exist" (Haignere, 2001, 2002). This represented a change in approach, from studying the salary residuals of individual faculty to fitting a model to assess systemic patterns across the entire university. Haignere argued that it was appropriate to apply remedies to classes of people, such as entire departments



**Fig. 2** Percentage of each demographic group: women, white males and other males that were flagged for low salaries from 1988 to 1998

or colleges, rather than to individuals. After fitting several variations of regression models, she concluded that women were paid on average about \$1000 less than white males and that other males were paid about \$2000 less than white males.

In 2001, NC State allocated over \$700,000 to adjust salaries to remedy these disparities. From 2000 to the present, salary equity studies have been conducted at approximately 3-year intervals. The average salary disparity for “other males” was reduced from \$2424 in 2001 to \$491 in 2006, and for women, it was reduced from \$1167 in 2000 to less than zero in 2006. In 2006, the average salary for women was actually \$491 higher than predicted by the white male equations.

NC State’s salary equity study continues to evolve. For the 2012 and the 2016/17 iterations, a committee of faculty and administrators provided advice, perspectives, and helped to coordinate information and approaches of all the various stakeholders: Faculty Affairs (the Vice Provost and an Associate Vice Provost), Institutional Equity and Diversity (the Vice Provost and the Assistant Vice Provost for Faculty Diversity), and faculty (the Chair of the Faculty, a faculty representative from the Council on the Status of Women, a faculty representative from the University Diversity Advisory Council). Staff from the Office for Institutional Research and Planning—OIRP (the Senior Vice Provost, Director of Institutional Analytics, and a graduate research assistant) prepared the data and fit the models and Human Resources (the Director of Classification and Compensation) also provided data, definitions, and explanations of data fields. The committee discussions were very helpful in deciding who exactly to include in the study: faculty with distinguished titles and named chairs? department heads? faculty with part-time administrative duties? During the process of fitting the model, many questions came up about data coding and definitions, so the expertise and participation of both Human Resources

and the Office of Research and Planning were crucial. When the study was complete, this committee was instrumental in developing a plan for sharing the results with all of the stakeholders: the provost, college deans, and the Faculty Senate.

The 2012 and 2017 salary equity studies differed in several ways from previous studies and also from each other. In the 2017 version, separate regression models were fit to all tenured and tenure track faculty in each college, with indicator variables for gender and race/ethnicity, rather than fitting the models to white males only. This provided enough data points (ranging from 41 faculty in the smallest college to 284 faculty in the largest) to enable us to fit a separate model for each academic college, which we felt was important, since the cultures and market forces are different for faculty in different colleges. In previous studies, we had found that the effects of race and gender varied among ranks within a college and that the variance in salaries was much greater for professors than for assistant professors, so in 2017, all of the model terms were nested within rank and the variance was allowed to vary by rank.

Another major change from previous years was to separate race and gender into three groups rather than two: (1) underrepresented minority (Black, Latinx, American Indian, Pacific Islander, Alaska native), (2) Asian, and (3) White. Starting in 2012, the median salary at a group of peer institutions for each faculty rank in each department, called the market salary, was included in the models. The 2017 model regressed  $\ln(\text{salary})$  on indicator variables for rank, gender within rank, and race/ethnicity within rank, distinguished titles, 9-month vs. 12-month appointments and on years of previous experience, years at NC State before current rank, years at current rank, and  $\ln(\text{market salary})$ . We considered including information on retention packages, but those data were not complete.

The 2017 model for each academic college was.

$$y_{ijklmno} = \beta_0 + R_i + E_{j(i)} + G_{k(i)} + D_l + U_m + C_n + \beta_1 x_{1i} + \beta_2 x_{2io} + \beta_3 x_{3io} + \beta_4 x_{4io} + \varepsilon_{ijklmno},$$

$$\varepsilon_{ijklmno} \sim iid \left( 0, \sigma_i^2 \right),$$

where the response is  $y_{ijklmno} = \ln(\text{salary})$ ,  $R_i$  is the  $i$ th rank effect,  $E_{j(i)}$  is the  $j$ th race/ethnic group effect within the  $i$ th rank,  $G_{k(i)}$  represents the gender effect within rank,  $D_l$ ,  $U_m$ ,  $C_n$  represent effects for distinguished titles, University Faculty Scholars, and Chancellor's Faculty Excellence Program faculty,  $x_{1i}$  is the log market salary for the  $i$ th rank, and  $x_{2io}$ ,  $x_{3io}$ ,  $x_{4io}$  are the years of previous experience, years at NC State before the current rank, and years at the current rank for the  $o$ th individual in the  $i$ th rank.

This model allowed us to estimate the median salary for each demographic group for each college. We found that for women in most of the 10 academic colleges and 3 professorial ranks, the median salaries were within 5% of the men's salaries. There were just two cases (assistant professors in one college and full professors in a second college) where the median salary for women was less than 95% of the

median for men. There were three cases where the median salary for women was higher than 105% of the median for men. The picture was much more variable for underrepresented minority (URM) faculty. For this group, the median salary was less than 95% of the median for white faculty in 6 rank/college cases and greater than 105% of the median for white faculty in 7 rank/college cases.

In addition to salary information, two additional important insights came out of the 2017 salary equity study when we looked at the demographic distribution of distinguished faculty titles. We found that the estimated odds of holding a named/distinguished professorship are substantially lower for women, underrepresented minority, and Asian faculty than for other full professors. The odds for URM faculty are 19% of others', for Asian faculty are 61% of others', and for women are 64% of men's. On the other hand, there are two new programs to honor faculty at NC State, called the Chancellor's Faculty Excellence Program (CFEP) and the University Faculty Scholars (UFS) program. In these programs, URM faculty and women are much better represented. The odds of being part of the CFEP program are 111% higher for URM faculty than other faculty in the same rank and college and the odds of being named a University Faculty Scholar are 56% higher for women than men.

## **JSM Diversity Mentoring Program**

The American Statistical Association (ASA) has a Member Initiative Program (<https://www.amstat.org/ASA/About/Board-Approved-Member-Initiatives.aspx>) in which ASA members can request funding for a project. In 2010, several faculty from NC State: Consuelo Arellano, Pam Arroway, Marcia Gumpertz, Jacqueline M. Hughes-Oliver, and Kim Weems; Rebecca Doerge from Purdue University; and Brian Millen from Eli Lilly and Co. proposed a Conference Mentoring Program. The program, called the Cavell Brownie Scholars program, was held at the 2010 Joint Statistical Meetings (JSM) in Vancouver, British Columbia. The program was named after Cavell Brownie, professor emerita of the North Carolina State University Department of Statistics. Dr. Brownie specialized in biometric methods, wildlife sampling, and statistical consulting from 1982 until she retired in 2008. She was born in Jamaica and served as an important mentor to generations of graduate students and junior faculty.

The 2010 Cavell Brownie Scholars program brought together 6 minority doctoral students and postdocs and 6 faculty mentors in a structured mentoring program at JSM. The program was specifically targeted to students who were preparing for faculty careers. The students and mentors met each day for 4 days of the conference for programs and networking. The programs included a presentation on multicultural history and who's who in Statistics, a roundtable discussion on what faculty life is really like at different types of institutions, a workshop for the students on the impostor syndrome, and a panel discussion for the mentors on best

practices for mentoring minority graduate students. Two comments from program participants illustrate the impact of the program:

“Participating in this program greatly enhanced my experience at the Joint Statistical Meetings, and it came at a very significant time in my academic journey. As I begin to apply for faculty jobs this fall, I will surely rely on the things I learned, the resources I gained, and the mentors I was introduced to to help make the process go smoothly.”

“I would like to let you know that as a result of the mentoring program we were part of in Vancouver, I was invited to give a talk at . . . Biostatistics Department”.

In 2011, the Cavell Brownie Scholars Program was combined with a Diversity Workshop at the Joint Statistical Meetings that was hosted by ASA’s Committee on Minorities in Statistics and again funded by ASA’s Member Initiative Program. At this time, the program was broadened to include mentoring for students interested in careers in government and industry as well as academic careers. In 2012, the ASA Board of Directors adopted the JSM Diversity Mentoring Program as one of its regular annual offerings to be funded through the Committee on Minorities in Statistics. The program has earned broad support among the sections of ASA and several corporations and national organizations. Several sections of ASA cosponsor the JSM Diversity Mentoring Program each year. As the program prepares for its tenth year, 2019 sponsors include nine ASA sections ranging from Statistics in Epidemiology to Bayesian Statistical Science, five corporations, two academic departments, and one nonprofit organization. The program has also steadily grown, though is still kept small and intimate; in 2018, 15 student/mentor pairs participated, once again in Vancouver, British Columbia.

## **Math Alliance**

It takes a village to raise a child, and that adage is also true for raising earned doctoral degrees in the mathematical sciences among the Black and Latinx communities. In the 1990s, the Department of Mathematics at the University of Iowa embarked in a campaign to increase the diversity of their graduate program. Their efforts, although earnest, could not have succeeded without a source of program candidates, and so their early partnership with the Mathematical and Theoretical Biology Institute/Institute for Strengthening the Understanding of Mathematics and Sciences (MTBI/SUMS, directed by Carlos Castillo-Chavez) was critical. The successful completion of 11 doctoral degrees from the initial pool of 15 candidates was a resounding success that laid the groundwork for broader appeal to the larger community.

With primary leadership in 2001 from Philip Kutzko of the Department of Mathematics at the University of Iowa, math sciences departments from three predominantly White institutions in Iowa (University of Iowa, Iowa State University, University of Northern Iowa) and four Historically Black Colleges and Universities (Alabama A&M University, Benedict College, Florida A&M University, Jackson

State University) formed a partnership called the *Alliance for the Production of African American PhDs in the Mathematical Sciences*. By 2006, the partnership had increased its institutional footprint to a national level and this was formally recognized with a name change—the *National Alliance for Doctoral Studies in the Mathematical Sciences*. The Department of Statistics at North Carolina State University had launched its own initiative in the early 2000s to diversify its graduate program and reached out for direct assistance from Phil Kutzko. As a result, North Carolina State University was one of the first institutions included in the expanded footprint of the Alliance. Statistical sciences have been an integral component of the Alliance from the beginning, with Dean Isaacson of the Department of Statistics at Iowa State University providing leadership until his retirement. In 2008, Kathryn Chaloner of the Department of Biostatistics at the University of Iowa formalized the *Alliance Statistics Initiative* to encourage and ensure the continued participation of statisticians in the Alliance.

Faculty in the Department of Mathematics at the University of Iowa were awarded a series of Graduate Assistance in Areas of National Need (GAANN) grants from the Department of Education that supported their underrepresented minority students. The collaboration with Iowa State University (involving both the Department of Mathematics and the Department of Statistics) and University of Northern Iowa preceded submission of a grant application to the National Science Foundation. The Alliance transitioned to funding from the National Science Foundation starting in 2002 until 2017. The Alliance is currently funded through an administrative home in the College of Sciences at Purdue University and with individual memberships by various departments offering degrees in the mathematical sciences.

The primary purpose of the Alliance, from its origin to now, continues to be diversifying the mathematical sciences through increased completion of graduate degrees. From its inception, the Alliance organized itself as a network of mentors and mentees. Mentees are designated as Alliance Scholars and can be either predoctoral (undergraduate or masters) or doctoral students. Alliance Mentors recruit promising undergraduate or Master's students and then nominate them to be Alliance Scholars. The nominating Mentor then commits to serving as a mentor to the student as they progress toward graduate school. This way of identifying students ensures that each Alliance Scholar enters the program with a mentor. The annual Field of Dreams Conference allows face-to-face interactions between mentors and mentees, provides success strategies to students, connects students to graduate programs and employers, and informs students of potential careers after graduate studies. A major characteristic of the Field of Dreams Conference is that Alliance Scholars are fully funded to attend. Scholars may, in their junior year, be nominated by their Mentor to join a special program—Facilitated Graduate Application Program (F-GAP)—that the Alliance provides to aid in the transition to graduate school. At this point, the student is provided with a second mentor at one of the Alliance doctoral programs who aids in development and review of graduate application. Students then attend the annual Field of Dreams conference with their mentoring team.



The Alliance reports that 83 students from the 2017–2018 F-GAP year enrolled in graduate school, with 59 of those enrolling in a PhD program. For the 2016–2017 F-GAP year, 87 students enrolled in graduate school, with 48 enrolling in PhD programs. During the period 2005 to 2017, 54 Alliance Scholars earned a PhD (in any field), with 48 earning their PhD in a mathematical science, and 39 of those earning their PhD in a mathematical science described as coming from a group underrepresented in the mathematical sciences.

## **StatFest**

Nagambal Shah was determined to expose her Spelman College students, along with other students at the surrounding Historically Black Colleges and Universities (HBCUs) that make up the Atlanta University Center (Morehouse College and Clark Atlanta University) to the variety of professional opportunities open to them from studying statistics. So in 2001, she invited a number of statistics professionals and graduate students to Spelman College to share their stories during a daylong session, and StatFest was born. Similar only in name to the NAM (National Association of Mathematicians, an organization focused on promoting the mathematical development of all underrepresented minorities) Undergraduate MATHFest, StatFest has the goal of encouraging undergraduate students from historically underrepresented groups to consider careers and graduate studies in the statistical sciences. Current graduate students frankly discuss their graduate programs, offer tips about how to prepare and succeed, as well as guidance on how to select a program. Established professionals from industry, government, research institutes, and academia talk about what they do, how they are challenged and keep themselves motivated and excited, their preparation for where they are, a typical day at the job, and offer sage advice.

The cluster of HBCUs in Atlanta provided a convenient pool of attendees for the first StatFest at Spelman College. Similar clusters were also beneficial for the second and third StatFests held at Hampton University and Meharry Medical College, both in 2002. StatFest quickly gained popularity and is now an annual event sponsored by the American Statistical Association (ASA) through its Committee on Minorities in Statistics. The Committee on Minorities in Statistics partners with organizations interested in hosting the event, and committee members serve on the conference organizing committee to provide assistance and maintain continuity of programming.

Started at an HBCU, StatFest has grown to involve more partners, with the impact being enhanced ability to reach larger populations of historically underrepresented students. The first time that StatFest was held at a predominantly White institution was in 2003, at North Carolina State University. The effort to convince historically underrepresented students and their faculty to attend was quite a challenge because there were no existing substantive relationships. The funding model also required a radical change because most attendees had to travel long distances. Funding

for StatFest is provided annually through the American Statistical Association, primarily through member-initiated activities and the sections of ASA. Substantial additional funding is also provided by the organizational host, and through their fund-raising activities targeted to the event. Federal funding agencies have not played a role in regularly supporting StatFest.

By agreeing to host a StatFest, organizations commit to raising funds and securing attendance by significant groups of historically underrepresented students. As such, an indirect impact of StatFest is that it highlights the commitment of organizations to the cause of diversifying the field of statistics. Since 2005, StatFest has been hosted by the University of Hawaii—West Oahu, Florida A&M University, University of Texas at El Paso, Eli Lilly and Company, Lamar University, University of Iowa, Spelman College, San Francisco State University, Rice University, North Carolina State University, University of Chicago, Howard University, Emory University, Amherst College, and University of Texas Health Science Center at Houston.

## **Platforms for Sparking and Supporting Faculty Initiatives**

We hope that this chapter provides inspiration and information to individuals about the broad scope of successful initiatives that have been and can be developed and promoted by individuals. The initiatives described in this chapter have been developed by individual faculty or by committees of faculty, staff, and students. Many other types of initiatives for creating an inclusive environment are possible within departments, such as starting a diversity listserv, organizing a brown bag lunch series for faculty and students interested in exploring inclusive teaching practices, introducing a seminar or colloquium on the intersection of diversity and Statistics, creating a professional development workshop series for women or underrepresented students, or building a relationship with a math department at a minority-serving institution.

Institutions, departments, and national organizations can promote faculty involvement in diversity efforts by building platforms that provide resources and recognition for these efforts. The following types of platforms have been particularly effective:

- Committees, working groups, and task forces.
- Grants programs.
- Faculty Fellow programs.
- Leadership development programs.

Committees, working groups, and task forces have provided the impetus for several of the initiatives described in this chapter. In particular, individuals serving on the Advisory Council for Women's Affairs, the University Diversity Advisory Council, and the Council on the Status of Women were responsible for the creation of the GLBT Center, the Salary Equity Study, and parental leave for graduate

students at NC State. Committees, working groups, and task forces provide a space for individuals to develop ideas, to interact with others who are committed to promoting diversity and inclusion, and provide a formal means of communication with the institutional leadership. Service on committees and task forces can be recognized as a legitimate and important faculty activity for managing university business.

An NC State Women's Faculty Task Force in 2006 produced a proposal for a National Science Foundation ADVANCE grant. Grants programs, both from national funding sources and internal institutional grants programs, are highly effective platforms for promoting diversity initiatives. In addition to providing funding for activities, research, and assessment, these programs may be highly prestigious and enhance the visibility of the diversity programs and the participating individuals and institutions. The JSM Diversity Mentoring Program was made possible by the ASA's Member Initiative Program, and StatFest has received funding through this program. The Member Initiative program is a unique program that provides a way for members to shape the activities and impact of the organization. National Science Foundation and Department of Education grants programs provided platforms for launching and funding the ADVANCE Developing Diverse Departments project at NC State and the National Alliance for Doctoral Studies in the Mathematical Sciences. The National Science Foundation and Eli Lilly conference grants also supplied the funding for diversity workshops and mentoring program at the Joint Statistical Meetings.

Through the NSF ADVANCE program, we were able to create a faculty fellows program and a leadership training workshop. The faculty fellows program engaged faculty from all 10 academic colleges, and those fellows have gone on to create an annual statewide forum for Latinx faculty, training materials for faculty search committees, and a bridge to the doctorate program for minority students in Engineering in addition to the policy on parental leave for graduate students described in this chapter. The ADVANCE Scholars and leadership team expanded the practice of providing tools to assist search committees in diversifying candidate pools and confronting implicit bias in evaluating candidates.

The leadership of NC State's Department of Statistics, Dan Solomon, Sastry Pantula, Tom Gerig, and Montse Fuentes has been instrumental in the development of the GLBT Center, hosting StatFest at NC State and adopting the Diversity Mentoring Program as one of JSM's annual events, fostering a welcoming climate for women in Statistics, and countless other ways of actively promoting and supporting diversity efforts at NC State and in the discipline of Statistics. They provided the model that allowed other members of the Statistics Department, including the authors of this chapter, to work on increasing diversity and inclusion.

The D3 leadership development program inspired women and minority faculty to move into leadership positions. Several have become department heads, directors of centers, associate deans, deans, and one provost. The program provided knowledge and skills development to all faculty, minority or not, to use positions of leadership to promote diversity and inclusion.

Our message to individuals is to seek out and make use of committees, grant programs, fellowship opportunities, and leadership development training to implement your ideas for enhancing inclusion in higher education. This is the way change happens in universities. Our message to university leadership is to create platforms for faculty to contribute ideas. Then, cultivate these ideas, put them into practice, and give the initiatives time to grow and change the landscape.

## Action Plans

High impact actions that individuals in different university roles can take:

- *Faculty*: Make diversity and inclusion a high-priority topic for discussion and have regular discussions within your department about the role of diversity in your department and discipline. Departments that hold regular discussions about how diversity impacts their field build a culture that creates an inclusive environment.
- *Faculty*: Actively work to recruit faculty, graduate students, and undergraduates from underrepresented groups to your department. Become knowledgeable about, participate in and make use of university and national resources and programs to enhance these efforts.
- *Department heads and faculty*: Develop a departmental plan for recruiting and retaining diverse faculty, graduate students, and undergraduate students. Implement the plan and revisit it annually to assess its effectiveness and make updates to it.
- *Provosts, deans, and department heads*: Incorporate efforts to enhance diversity and inclusion into the instruments used to evaluate faculty for annual raises and for promotion and tenure. Evaluate department heads and deans on their success in recruitment, retention, and success of diverse faculty and students.

## References

- Haignere, L. (2001). *North Carolina State University report on the university wide salary-equity study*. Unpublished report. Retrieved from <https://oied.ncsu.edu/divweb/wp-content/uploads/2018/10/NC-State-2001-Salary-Equity-Report.pdf>.
- Haignere, L. (2002). *Paychecks: A guide to conducting salary-equity studies for higher education faculty* (2nd ed.). Washington, DC: American Association of University Professors.
- Scott, E. L. (1977). *Higher education salary evaluation kit*. Washington, DC: American Association of University Professors.

# University Faculty Salaries: Comparing Patterns of Gender Inequity to Those in the General Workforce



Mary C. Meyer

**Abstract** Patterns of gender inequity seen in the general workforce also occur among university faculty, despite faculty having strong similarities in education and job description. Identifying causes for these patterns and eliminating barriers for women in academia could set the example and promote gender equity in the general population.

## Introduction and Background

A 2010 report of the Joint Economics Committee (Democratic staff of the Joint Economics Committee 2010) noted that women in the USA earned 77 cents, on average, for every dollar earned by men. This is in spite of women comprising half the work force and being awarded almost 60% of the bachelor's degrees. Common "explanations" of the gap include type of job, with men tending to populate the more lucrative career tracks, and gender differences in family and household burdens, with women shouldering a greater load and hence having less time to build a career (Feder and Collins 2016).

Within type of job, the gender pay gap is smaller. Traditionally male occupations often have more prestige and higher salaries, whether or not they have more economic value and social importance; this causes the overall gap to be larger than the individual gaps within job category. Further accounting for rank within the job category as well as time in rank, the gap persists but is still smaller. Women are typically underrepresented in the higher-paying ranks of large companies, compared to their representation in the lower ranks (Democratic staff of the Joint Economics Committee 2010).

A 2012 report by the American Association of University Women (AAUW) (Corbett and Hill 2012) describes a gender gap in pay at the very start of careers

---

M. C. Meyer (✉)  
Statistics Department, Colorado State University, Fort Collins, CO, USA  
e-mail: [Mary.Meyer@colostate.edu](mailto:Mary.Meyer@colostate.edu)

of graduates with bachelor's degrees, even within field of study. They examined the salaries of college graduates 1 year after graduation and found that women working full time made just 82% of their male counterparts. Accounting for field of study, women made 93%, on average, of male salaries. The report notes, "Explaining or accounting for a portion of the pay gap simply means that we understand the effect of certain factors, not that the gender differences related to those factors are necessarily fair or problem-free. Both discrimination and cultural gender norms can play a role in the 'explained' portion of the pay gap."

In the university setting, we observe the same patterns, although for faculty, all have roughly the same level of education and duties. Especially within an institution, the job descriptions of research, teaching, and service are similar across departments, and it is easy to control for field and seniority. In this work, we examine salaries at Colorado State University (CSU) in the years 2017 through 2019 and specifically compare salaries for female and male tenured and tenure-track faculty (TTF).

In response to concerns of senior women faculty, the CSU provost's office appointed a committee in 2016 to determine salary equity, specifically if there are gender gaps in the TTF salaries. Committee members consisted of (mostly female) faculty from each college, as well as administrators including the director of Institutional Research. In addition to determining the overall status of salary equity at CSU, the committee was charged to make recommendations for an annual procedure at the department level to determine where equity raises may be appropriate.

In fiscal year 2017, the average salary for male TTF was 14.7% higher than that for female TTF; that is, female faculty were paid 85.3 cents on the dollar paid to male faculty. This is a somewhat smaller gap compared to that in the general public, but because we have a closer equality of education level, job description, and responsibilities among faculty members, this gap may be considered surprisingly large.

This gender gap varied by faculty rank: the salary was 2.6% higher for male assistant professors, 9.3% higher for male associate professors, and 13.4% higher for male full professors. The gaps in each rank were smaller than the overall gap, because the percentage of women faculty decreases as rank increases and decreases more sharply in higher-paying departments. This is similar to the patterns in the general public, with women becoming more scarce as salary and prestige increase.

In universities within the USA, faculty compensation varies by field. As in the general public, fields that have a higher proportion of male faculty tend also to have higher salaries. For example, salaries in the Engineering College tend to be considerably higher than salaries in the College of Liberal Arts. Again, arguments can be made that this difference in salaries is unjust, reflecting the gender bias of our culture, or market-force arguments can be made to defend the difference. Without conceding this argument, it is of interest to determine if the gender gap persists when field, rank, and seniority are accounted for.

## The Statistical Model

The CSU salary committee debated which predictors of salary to use in the statistical model. They agreed that job descriptors only should be used to predict salary. That is, no indicator of awards or appointments to distinguished professor status were used, as these appointments or awards might themselves have an element of gender bias. Rank, department, and years in rank were the only variables that were controlled for to determine the gender equity status of faculty salaries. Department chairs were included in the analysis, but no administrative ranks at the assistant/associate dean level or above. Nine-month salaries were used, so that salaries for faculty on 12-month appointments were multiplied by 0.75.<sup>1</sup> Data were provided by the CSU Office of Institutional Research.

In 2017, there were 1060 tenure-track faculty in the data set: 410 women and 650 men. Because the distribution of salaries tends to be skewed, we used the logarithm of the salary as the response variable. For each of the three ranks, we obtained a least-squares fit for the following model:

$$\begin{aligned} \log(\text{salary}) = & \text{constant} + \text{effect of male} + \text{department effect} \\ & + f(\text{years in rank}) + \varepsilon. \end{aligned} \quad (1)$$

The function  $f$  is assumed to be smooth and increasing; no other assumptions are made about its functional form. The term represented by  $\varepsilon$  is the component of salary that is unexplained by gender, department, and years in rank.

For assistant and associate professors, no gender gap was found after the effects of department and years in rank are accounted for. The overall gaps at these ranks have been “explained” by the difference in field; that is, men tend to be in departments with higher salaries. For full professors, however, a substantial salary gap was found even after department and years in rank were accounted for: male full professors made 5.1% more than female full professors. This gap was statistically significant with a  $p$ -value of 0.0054.

The news of a gender gap at the full professor level generated discussion within the university as well as in the surrounding community (Coltrain 2017), and some measures were put in place to determine where equity raises would be appropriate. The next year, in fiscal year 2018, the gap was reduced. When controlling for department and years in rank, male full professors made 3.5% more than female full professors. The  $p$ -value for this gap was 0.056, and because this is larger than the usual 0.05 level for statistical significance, an announcement was made that gender equity was achieved (Coltrain 2017). In FY19, the gap was further reduced to 3.1% and the  $p$ -value increased to 0.079 (Jackson 2018).

---

<sup>1</sup>This multiplier is sometimes taken as 0.82 or 9/11, but the 0.75 multiplier is used to convert salaries for department chairs, before and after appointment.

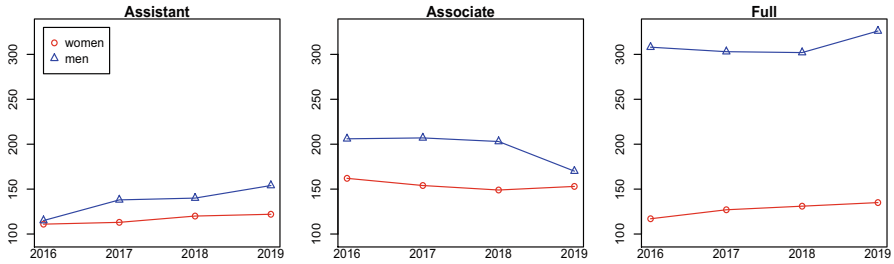


Fig. 1 Trends of numbers of tenure-track and tenured faculty at Colorado State University

The current salary gap of 3.1%, which amounts to about \$3800 per year on average, is practically significant even if the  $p$ -value is larger than 0.05. The larger  $p$ -value is in part a reflection of the lack of statistical power for the test, due to small numbers of senior women. Figure 1 shows numbers of women and men faculty at CSU for a 4-year span. Mirroring the patterns of female and male employees in the general population, women become scarcer as the rank increases.

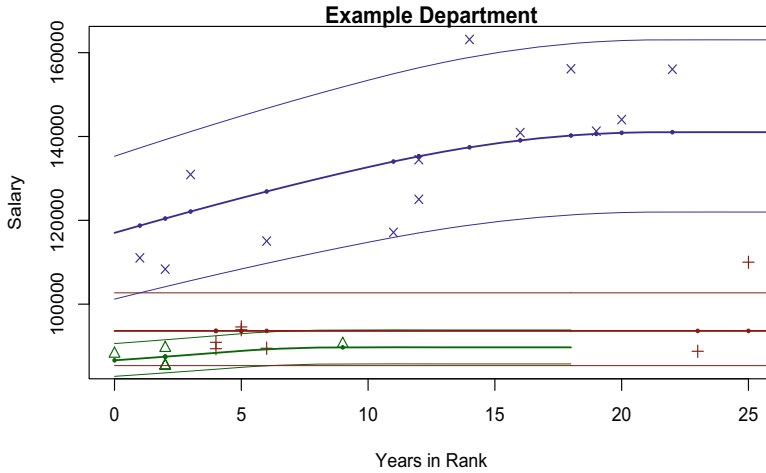
A larger number of senior women faculty, with the same gap, would result in a smaller  $p$ -value. To demonstrate this, we created a new data set, using the same data but doubling the number of female full professors (note that this still leaves the women in the minority). Each female full professor at CSU got a “twin” in the same department, with the same years in rank and the same salary. For this fabricated data set, the salary gap is the same, but the  $p$ -value is less than half the size, making it smaller than 0.05 so that the gap is considered “statistically significant.” Although the gap has been diminishing over the past several years, finding a  $p$ -value slightly greater than 0.05 should not be taken as an indication that equity is achieved; it might be a lack of power due to a small number of women at the full professor rank. The statistical fallacy of concluding that equality holds because the  $p$ -value is greater than 0.05 is discussed in more detail in Wasserstein et al. (2019).

The methods discussed here may also be used to determine if a salary gap exists for under-represented minorities, simply by changing the gender variable to indicate minority status.

## Conclusions and Recommendations

The ability to negotiate a higher salary requires the knowledge of expected salary and the salaries of peers. Transparency of salaries and salary analysis is a starting point of achieving pay equity. The CSU salary committee recommended that annual reports and accessible graphics be provided to facilitate the assessment of relative pay within departments, for individual faculty as well as chairs and deans. An example of such a report is shown in Fig. 2, where salary is plotted against years in rank for all TTF in an example department. The color and plot character reflect





**Fig. 2** Snapshot of current salaries with superimposed model fit, for an example department at CSU. The plot characters are different for the three ranks, the dark curves represent the trends of CSU salaries with years in rank, and the lighter curves are placed at one standard error from the trend

the rank, with  $\times$  indicating full professors,  $+$  indicating associate professors, and triangles indicating assistant professors. The darker curves are the fits to the model using the trend functions and the department effects for each rank. (The “trend function” can be thought of as the expected salary for an “average” department member with a given number of years in rank.) The lighter curves are placed at one model standard error from the trend curves. The variance in salaries is highest for full professors and lowest for assistant professors. The trend for associate professors is flat, in part because of a recent CSU policy to increase the pay raise at the time of tenure and promotion to associate professor. That is, more recent associate professors often make as much or more than those senior in that rank. In addition, associate professors who have been many years in rank without promotion often have salaries that are lagging compared to faculty more recently promoted to that rank.

With such plots available to faculty, department chairs, and deans, assessment of an individual’s salary relative to others in the department is clear; this can be used as a starting point for ensuring fair and equitable assessment and correction of individual salaries.

The patterns of gender and rank at CSU are similar to those in Category-I universities<sup>2</sup> nationwide, where we see that about 47% of assistant professors are women, but 41% of associate professors and only 24% of full professors are women (AAUP 2014). Is the scarcity of women at the senior level due to previous scarcity at

<sup>2</sup>Carnegie classification indicating research university.

the lower levels, or are women leaving academia at greater rates than men? Statistics given in a TIAA report (Finkelstein et al. 2016) suggest the latter. In 1993, 37% of tenure-track faculty at public research universities were women; this increased to 40% in 2003 and 45% in 2013. While this trend in percentage of female assistant professors is encouraging, we would expect a higher percentage of female full professors today if women were being retained and promoted at the same rates as men. The problem of recruiting and retaining senior women in academia could be considered as great a problem as gaps in salary.

The degree of this problem varies by field. For CSU departments with above-average salary effects from the fitted model (1), women comprise less than 20% of the full professors, down from about 40% women at the assistant and associate ranks. In contrast, departments with below-average salaries have about 50% women at the assistant and associate levels, and about 39% of the full professors are women. The attrition of women seems to be greater in the departments with higher salaries. As these departments tend to be the traditionally male fields, a cultural climate detrimental to women may be the cause.

Cultural climates in academic departments were described by Britton (2017) and references therein. They cite the following barriers to success for women in academia: biases in hiring practices and award distribution as well as in teaching and service burdens, exclusions from professional networks, and biased perceptions of women's research productivity. Awareness and open discussion about climate and the effects on women is a crucial first step toward resolution. Canetto et al. (2017) examined the reasons given by female graduate students in STEM disciplines for not choosing an academic career; concerns about having a family were prominent. On-site childcare and parental and family leave policies that encourage men to take an equal share of responsibilities might alleviate some of these concerns and make choosing and staying in an academic career more attractive to women.

In academia, patterns of salary inequity and differences in gender composition by field and rank mirror those in general employment. Reasons for these differences also mirror those in the general population. Cultural patterns are difficult to change, but the academic world should be in the forefront, taking the necessary steps to ensure equality.

## Action Points for Colleges and Universities

- Yearly assessment of gender gaps in salaries can identify problems and track trends in salary differences across time. These assessments should not rely on *p*-values alone, as small sample sizes could result in insufficient power to detect practically significant difference in salaries. Women should be well represented in salary equity committees.
- Differences in salaries that are due to retention raises should not be allowed to persist—salaries of equally qualified faculty who do not have retention raises should gradually be brought up to the same level. This recognizes that factors

other than merit often prompt faculty to seek outside offers and that faculty with family are at a disadvantage.

- Universities should recognize the difficulties of combining the tenure track with parenting and that these difficulties unfairly burden women more. On-site childcare is a reasonable expectation at any large institution. At CSU and other universities, “lactation rooms” have been established with some fanfare, but they are not as useful if the baby is many miles away at day care.
- Service load should be measured more precisely than counting the number of committees each faculty member serves on. In every department, an effort should be made to estimate and equalize the number of hours spent on service.
- Exit interviews for women leaving the university might shed light on the particular changes needed to attract and retain women in academia. Some of those conducting interviews should be independent of the department or unit.

## Technical Appendix

The discussion of the model uses the rank of full professor; for other ranks, the same model is used. Three separate models were used because of differences in variance—the full professor salaries have higher variance than the assistant or associate professor salaries.

Let  $y_{ji}$  be the logarithm of the salary of the  $i$ th full professor in the  $j$ th department, let  $x_{ji}$  be her or his years in rank, and let  $z_{ji} = 1$  if the  $j, i$ th professor is male and  $z_{ji} = 0$  if the  $j, i$ th professor is female. The model to predict log-salary is

$$y_{ji} = \beta_j + \alpha z_{ji} + f(x_{ji}) + \varepsilon_{ji},$$

where  $\beta_j$  is the average log-salary for a woman full professor in the  $j$ th department with zero years in rank. The parameter  $\alpha$  represents the effect of being male; male full professors in the  $j$ th department with zero years in rank have average log-salary of  $\alpha + \beta_j$ . Male full professors make  $100e^\alpha\%$  more than female full professors; for example, if  $\alpha = 0.036$ , the gender gap in pay is 3.7%. This salary gap is modeled to be the same across departments. That is, the interaction between gender and department was not found to be statistically significant.

The function  $f$  has zero intercept and is assumed to be smooth and increasing. The “error” term  $\varepsilon_{ji}$  represents the deviation of the  $j, i$ th salary from the expected, and these errors are assumed to have mean zero and to be approximately normally distributed.

This model can be fit with the R package `cgam` (Liao and Meyer 2019). For example, the command in R for the appropriately defined data vectors is

```
fit=cgam(y=factor(department)+male+s.incr(yrs_in
                                             _rank)).
```

The predicted log-salaries are in the vector `fit$muhat`, and the residuals are `y-fit$muhat`. The command `summary(fit)` provides estimates of the effects

of department, years in rank, and gender, along with standard errors and  $p$ -values. For the CSU data, residual analyses showed no substantial deviations from the model assumptions for any of the ranks.

For the annual department plots to reveal salaries and expected salaries for the purposes of determining raises, it is crucial to omit the gender variable and model salary as depending only on department, rank, and years in rank.

## References

- AAUP. (2014). 2013-14 annual report on the economic status of the profession. [https://www.aaup.org/sites/default/files/files/2014%20salary%20report/zreport\\_0.pdf](https://www.aaup.org/sites/default/files/files/2014%20salary%20report/zreport_0.pdf)
- Britton, D. M. (2017). Beyond the chilly climate: The salience of gender in women's academic careers. *Gender and Society*, 31(1), 5–27.
- Canetto, S. S., Trott, C., Winterrowd, E., Haruyama, D., & Johnson, A. (2017). Challenges to the choice discourse: Women's views of their family and academic-science career options and constraints. *Journal of Feminist Family Therapy*, 29(1–2), 4–27.
- Coltrain, N. (2017, November 19). CSU reports it's [sic] closing gender pay gap. *The Coloradoan*.
- Corbett, C., & Hill, C. (2012). Graduating to a pay gap. Technical report, American Association of University Women.
- Democratic staff of the Joint Economics Committee. (2010). Gender pay inequality: Consequences for women, families, and the economy. Technical report, U.S. Senate.
- Feder, J., & Collins, B. (2016). Pay equity: legislative and legal developments. Technical Report 7-5700-[www.crs.gov/RL31867](https://www.crs.gov/RL31867), Congressional Research Service.
- Finkelstein, M. J., Conley, V. M., & Schuster, J. H. (2016, April). Taking the measure of faculty diversity. Technical report, TIAA Institute.
- Jackson, P. (2018). Channels: FY19 faculty salary equity study shows no statistically significant gaps by gender, race. <https://source.colostate.edu/fy19-faculty-salary-equity-study-shows-no-statistically-significant-gaps-by-gender-race/>
- Liao, X., & Meyer, M. (2019). cgam: An R package for the constrained generalized additive model. *Journal of Statistical Software*, 89(5), 1–24.
- Wasserstein, R. L., Shirm, A. L., & Lazar, N. A. (2019). Moving to a world beyond  $p < .05$ . *The American Statistician*, 73(1), 1–19.

# Establishing and Maintaining Inclusive Pipelines



Jeffrey D. Dawson and Gideon K. D. Zamba

**Abstract** Establishing and maintaining student pipelines is an important and challenging endeavor. We discuss how to create an inclusive environment, make connections to build pipelines, and provide continuing maintenance. The emphasis is on pipelines between undergraduate and graduate programs; however, analogous strategies can be employed between high schools and undergraduate programs.

## Introduction

This chapter describes efforts made to increase diversity among students in University of Iowa's Department of Biostatistics, via the establishment and maintenance of pipelines. Because our department is the academic home of three graduate programs (MPH, MS, and PhD), the emphasis is on pipelines between undergraduate and graduate programs; however, parallel strategies could be employed to establish pipelines between high schools and undergraduate programs. The use of the term "we" in this chapter represents the efforts of the entire department of biostatistics, including faculty, staff, and students. See "Acknowledgment" section for a description of the authors' roles and for the names of other key personnel.

Establishing, nurturing, and maintaining student pipelines is a complicated process. In this chapter, we consider the following aspects:

- Creating an inclusive environment
- Making connections to build pipelines
- Pipeline maintenance

Although we discuss these aspects as if they were somewhat chronological in nature, it is important to point out that they may be multidirectional and iterative in practice. For example, as one maintains a particular pipeline, this will have a

---

J. D. Dawson (✉) · G. K. D. Zamba  
Department of Biostatistics, University of Iowa College of Public Health, Iowa City, IA, USA  
e-mail: [jeffrey-dawson@uiowa.edu](mailto:jeffrey-dawson@uiowa.edu); [gideon-zamba@uiowa.edu](mailto:gideon-zamba@uiowa.edu)

tendency to strengthen the inclusivity of the environment, which can lead to other pipeline opportunities and so forth.

## Creating an Inclusive Environment

It takes a concerted effort to recruit and mentor a diverse group of students, and it may be impossible to achieve proportionate representation according to every factor that might be used to categorize students. However, it is the hope that if one creates an environment of equity and inclusion, targeting groups that appear to be under-represented, then everyone will have a chance to succeed, regardless of known and unknown demographic factors. For example, if an academic program is designed to help students succeed regardless of gender, ethnicity, race, or nationality, then hopefully all students will have a chance, regardless of other factors, such as religion, disability status, political views, sexual orientation, and other demographic characteristics.

One key attribute of an inclusive environment is one that emphasizes **collaboration** over competition. This can be done at several levels. First, we have the goal that all admitted students will graduate from the program in which they enroll, though time to completion may vary. This goal may sound very basic and obvious, but if an institution's program admits a high number of students with the expectation that a certain percentage of them will drop out (perhaps even intentionally designing so-called "flunk-out courses"), then such a program does not have this goal, and will be emphasizing competition over collaboration and cooperation. This approach is by no means synonymous to diluting academic training, rigor, and expectation, but rather achieving an excellent academic result by creating an environment where students flourish. Second, having courses with group projects essentially forces students to collaborate, learning from each other both in terms of tangible skills, as well as from the diversity of perspectives and backgrounds that students bring with them. Finally, we are very strategic when it comes to creating and bestowing special awards to our students. Rather than just offering a "top student" award, using a high GPA as a primary criterion, we have modest awards for such things as outstanding work as teaching assistants, research assistants, and service/citizenship. This helps spread the wealth a bit, but more importantly, it sends a message to all of our students (awardees and non-awardees) that we value and appreciate all of the efforts our students make—not just their academic excellence as reflected by their GPA.

Related to the importance of a collaborative environment is the philosophy of playing with the **cards we are dealt**. Some students come in with known challenges, such as first-generation students, those who are reentering school mid-career, those with known disabilities, or those with complicated family situations. Other students have some challenges and weaknesses (as well as some strengths) that were not apparent when they applied. We monitor the progress of *all* of our students and brainstorm at faculty meetings on how to help those struggling academically. For example, when some of our students were struggling in their more theoretical

courses, the department scraped together the necessary funds to hire some more senior graduate students to act as tutors or part-time TAs, imparting additional help beyond that which the instructors in those courses were providing.

We have also found it extremely valuable to have an active **student organization**, with social and academic activities. Our biostatistics graduate student organization organizes a variety of social activities according to the interests of the students, including picnics, holiday parties, movie nights, intramural teams—to name a few. It has been our observation that participation in the various activities has been across all demographic lines, and that these things have increased the camaraderie and positive attitude of our students. Academic activities of the student organization have included journal clubs, job search/interview workshops, and group travel to academic meetings. As a department, we try to allocate funds for partial support for students attending statistical meetings, especially when they are presenting their own research. This is more economically efficient for regional conferences and workshops, but there have been many cases when the department has rented vehicles for students to travel to national meetings (e.g., JSM) when those are held within a close geographic proximity.

## **Making Connections to Build Pipelines**

Many of our efforts to build pipelines have been in conjunction with a formal summer program that we have hosted since 2008, where undergraduates are introduced to the fields of biostatistics and statistics. In the fall of 2007, the Department of Biostatistics initiated a small-scale summer program run on departmental funds and assisted by the National Alliance for Mathematical Sciences (“the Alliance”) and Dr. Philip Kutzko’s NSF REU award. Undergraduates with a mathematics and/or biology background were recruited through the Alliance network. In the summer of 2008, we piloted this biostatistics program with four undergraduate students, all of whom were URM (“Under-Represented Minority”) females, three of whom went on to careers in biostatistics-related fields and one in dentistry. They completed an 8-week training that included biostatistics training and individual projects, with each student having a faculty mentor. Since the summer of 2008, this summer biostatistics program has grown, matured, and evolved. It has been funded through multiple NIH/NHLBI awards over the years under various official names and grant numbers (see Acknowledgments), but is referred to herein as ISIB (“Iowa Summer Institute of Biostatistics”). ISIB has some similarities to summer biostatistics programs run at other large research universities (“SIBS,” for “Summer Institute in BioStatistics,” <https://www.nhlbi.nih.gov/grants-and-training/summer-institute-biostatistics>), but has an emphasis in recruiting and training URM students, as well as students from small liberal arts institutions that have no formal undergraduate programs in statistics or biostatistics. The primary goal of ISIB is to introduce diverse groups of undergraduate students to biostatistics and related fields, with the hope that the pool of students entering graduate schools and the

statistical workforce will increase in size, quality, and diversity. This is done through a program that involves classroom instruction, computer labs, research projects, and exposure to our field via field trips, invited talks, and other activities.

Our efforts to establish pipelines have often been in the context of recruiting students into the above-described ISIB program, but these efforts have also yielded great students who have joined our graduate programs without attending our ISIB program. Hence, institutions without a formal summer program may also benefit from establishing pipelines. The three main approaches we have taken are working with established networks and communities that involve URMs, having a presence at national conferences aimed at URMs, and visiting individual institutions.

With regard to working with established networks, we have been involved with the Alliance, which is a community of mathematical and statistical science faculty working to increase the number of URMs attending graduate school, as well as with the Heartland Mathematics Partnership, which includes mathematics departments at institutions in the Midwest. In both of these networks, relationships are cultivated with mathematical science faculty members. These types of relationships have helped us recruit undergraduates attending institutions in the Midwest, South, Southwest, and Puerto Rico. We have had success attracting applicants from the East Coast (enrolling trainees from Simmons College, Mount Holyoke College, and the University of Syracuse, for example). As of late, we have developed relationships in the Pacific Northwest region of the USA, specifically from Wyoming, through the Alliance mentorship. The Alliance has recently expanded to include faculty members in mathematics in California, and we have sought relationships with the Alliance in California. We have successfully recruited from California Polytechnic (Cal Poly) at Pomona.

The Field of Dreams Conference of the Alliance was established in 2007 to bring minority mathematics majors together to learn about opportunities in graduate school in the mathematical sciences. The initial few conferences only involved graduate programs in Iowa (the three Iowa Regents' institutions: University of Iowa, Iowa State University, and University of Northern Iowa) but have since expanded to include several graduate programs, and the conference is now open to all. We have been a regular participant and panelist at the Field of Dreams conferences. In addition, our graduate students have been used as panelists where they describe our graduate program and their reason for pursuing their graduate training at the University of Iowa.

The Heartland Mathematics Partnership was established by an NSF Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE) award to the UI Department of Mathematics. The VIGRE award funded an REU which recruited from small colleges in the Midwest, for example, Grinnell, Central, Coe, Luther, Simpson, and Wartburg Colleges as well as two University of Wisconsin campuses (at Eau Claire and La Crosse). Other colleges are more regional but attract talented students. Good relationships have resulted with statistics and mathematics faculty at these institutions and these relationships have been nurtured. Although VIGRE is no longer operational, the network built through it is still alive and available. We make good use of this network in our recruitment efforts.

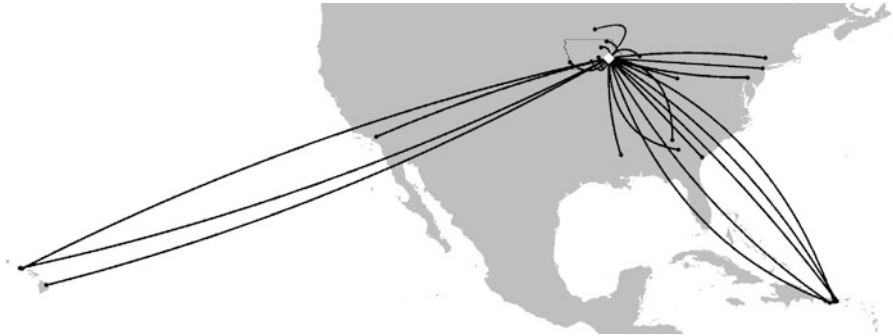


Biostatistics faculty members have been attending conferences aimed at URM students since 2007. URM students identified at these conferences have been recruited to ISIB and to our graduate programs as well. Specific conferences include as follows: Alliance for Graduate Education in the Professoriate in Mississippi (AGEP), Urban Conference, City College, NY, The Society for Advancement of Chicanos and Native Americans in Science (SACNAS), the Annual Biomedical Research Conference for Minority Students (ABRCMS), Interuniversity Seminary of Mathematical Sciences Research in Puerto Rico (Seminario Interuniversitario de Investigación en Ciencias Matemáticas, or SIDIM), Florida Georgia Louis Stokes Alliance for Minority Participation (FGLSAMP), and Field of Dreams. Through their attendance, faculty members have successfully recruited students to graduate and summer programs, and established connections with faculty members at minority-serving institutions.

The final and perhaps most successful strategy to establish pipelines is to build academic relationships of collaboration, mutual trust, and symbiosis with these institutions. Over the years, we have been successful at implementing and nurturing a sound relationship that has grown strong to become a research education network between UI Biostatistics and some well-established minority-serving institutions in the nation. We have discovered that there is no substitute to **paying direct visits to these minority-serving institutions** and building a level of trust and direct collaboration with both the faculty and their students. When an academic relationship is established, it is important to nurture and maintain it. Our strategy in this area consists of being physically visible, giving talks and departmental colloquium, spending time with the faculty and students, and presenting both our graduate program and the ISIB program to them along with our objectives and vision for the field. Establishing relationships with the faculty who mentor our targeted group is a long-term approach and also an effective one. Over the past 10 years, with support from the department, college, and ISIB grants, we have been able to broaden and maintain an effective network of academic relationships with minority-serving institutions and some small liberal arts colleges with little exposure to statistics. Figure 1 displays this network that serves as a direct referral mechanism into our ISIB program. How does the network function? Outstanding students who satisfy our admission GPA requirements are identified by local faculty of contact from these institutions. The faculty of contact is usually one or more math professors with direct knowledge of the students' ability. The students are then directly referred to us for a telephone interview to gauge their quantitative level, their level of interest in biostatistics, their plan for graduate school, and their future goals. If our interests form a match, we expedite their application as quickly as possible. In this network, we have two general categories of institutions:

Small Liberal Arts Colleges:

Carleton College, Minnesota  
Cornell College, Iowa  
Creighton University, Nebraska  
Grinnell College, Iowa



**Fig. 1** Academic Relationship Network for direct referral

Luther College, Iowa  
 Simpson College, Iowa  
 Vassar College, New York  
 Wartburg College, Iowa  
 Wheaton College, Illinois

Minority-serving Institutions

Cal Poly Pomona, Pomona, California  
 Central State University, Ohio  
 Jackson State University, Mississippi  
 Kean University, New Jersey  
 Lincoln University Pennsylvania  
 Middle Georgia/University of Georgia, Georgia  
 Pontifical Catholic University of Puerto Rico en Ponce, Ponce, Puerto Rico  
 Savannah State, Georgia  
 Spelman College, Atlanta, Georgia  
 University of Hawaii at Hilo, Hawaii  
 University of Hawaii at Mānoa, Honolulu, Hawaii  
 University of Hawaii at West Oahu, Oahu Hawaii  
 University of Puerto Rico at Cayey, Puerto Rico  
 University of Puerto Rico at Humacao, Puerto Rico  
 University of Puerto Rico at Mayagüez, Puerto Rico  
 University of Puerto Rico at Rio Piedras, Puerto Rico

**Pipeline Maintenance**

It takes diligence, commitment, and frequent visits to maintain this academic network. The two major aspects of this are continuing visits to institutions, and nurturing of current students and alumni who came from the targeted institutions

Regarding continuing visits, various faculty have made frequent trips to Cornell College, Grinnell College, Luther College, Simpson College, Wartburg College, and Coe College to bring visibility to our summer program and give talks to inform faculty and students about the urgent need for biostatisticians in the health sciences. Dr. Zamba frequently visits four universities in one trip to Puerto Rico. Since these universities are an hour or two away from each other, a two-day single trip suffices to cover all four universities, give talks, spend time with key faculty members, and recruit high-quality quantitative students. Dr. Kamuela Yong, a native Hawaiian who graduated from the University of Iowa Department of Mathematics, has been instrumental in our effort to begin a relationship with the Universities of Hawaii and introduce biostatistics and statistics to their students as a potential career option. This has helped us develop relationships with faculty in the Department of Mathematics of the University of Hawaii campuses in Mānoa, Hilo, and West Oahu. Dr. Zamba frequently visits these institutions for technical talks and visibility, which has led to multiple Hawaiian students joining our programs. Dr. Zamba has also made regular visits to Lincoln University in Chester, PA, the first HBCU (historically black college or university) in the nation, and Kean University, New Jersey, to give technical talks and present biostatistics to students and faculty. Another institution in the network is Savannah State University, Georgia, where Dr. Zamba is involved as an advisor to their MARC and their RISE Scholarship Advisory Boards.

The second aspect of pipeline maintenance is symbiotic with having an inclusive environment. Of course, we want all of our students to succeed, regardless of whether they were recruited via our pipelines. However, for the “pipeline students,” we do realize that their success in our program and in their career will strengthen our pipelines. They will be alumni for us and for their undergraduate institutions, and are thus examples that can be helpful for future recruitment efforts. Thus, as we invest time, energy, and resources into the education and nurturing of our students, there can be dividends that benefit our current students, as well as our future students that may come from our pipelines.

## Historical Results

Our Department of Biostatistics in the College of Public Health evolved from a Biostatistics Division of the Department of Preventive Medicine and Environmental Health in the University of Iowa College of Medicine in 1999. We have always had much diversity within our program in terms of gender and nationality, with international students representing six different continents over the years. In the period of 1999–2007, however, we were unable to recruit any domestic URM students to enroll into our graduate programs. Through the efforts described herein, in the period of 2008–2018 we were able to recruit and graduate 14 URM students, which is 10% of the 140 total for that time period. Currently, we have nine URM students (18% of 50 total students) in our programs and 30 (60%) females. We are

very pleased with the quality and diversity of our students, and we look forward to maintaining current pipelines and developing new ones to build upon our success.

## Action Plan

It has been said that success comes to those who are willing to work for it. This is certainly true when it comes to establishing and maintaining pipelines. Graduate programs that seek to establish pipelines with undergraduate institutions, as well as undergraduate programs seeking to establish pipelines with high schools, must consider their strengths, weaknesses, and resources, as they strategized to develop their niches. Just like an academic program can benefit from a diversity of students, faculty, and staff, so can the fields of biostatistics and statistics benefit from a diversity of programs of different sizes, styles, philosophies, and emphases.

The best formula for establishing pipelines for a specific institution will depend on a variety of factors, such as available resources, strengths and weaknesses of current faculty, unit priorities, and existing networks. Most institutions should be able to make progress through some combination of the following steps:

- Consider qualitative factors (statement of purpose, letters of recommendation, student intent), rather than just traditional metrics like GPA and standardized test scores, when making decisions for admissions and award.
- Eliminate “flunk-out” courses and other programmatic aspects that send the message that a large percentage of students are expected to fail.
- Encourage students to establish a student organization, with faculty support, and involve them in departmental decisions, as well as in student and faculty recruitment.
- Empower faculty to reach out to potential pipeline institutions when they travel for conferences, guest seminars, and vacations.
- Investigate what other academic units in your institution are doing to establish pipelines and emulate appropriate aspects of their approaches.

**Acknowledgments** The ISIB program has been funded by NIH/NHLBI as both T15 and R25 grants (T15 HL097622-01; T15 HL097622-04; R25 HL131467-01; R25 HL147231-01), and we thank the NIH/NHLBI for their generous support. Dr. Dawson was the Director of Graduate Studies (DGS) from 2003 to 2012 and is still actively involved in the ISIB program. Dr. Zamba is the principal investigator of the ISIB program and was the program co-leader with our department head Dr. Kathryn Chaloner from 2007 until her passing in 2014. All faculty in the department, as well as many staff and students, have been actively involved in the recruitment and mentoring efforts described herein. We particularly recognize Ms. Terry Kirk (Graduate Program Coordinator), Dr. Jacob Oleson (current DGS and chair of admissions and recruitment committee), and Dr. Joseph Cavanaugh (current department head) for their efforts over the years. Dr. Brian Smith (UI Professor of Biostatistics) and Dr. Kate Cowles (UI Professor of Statistics and Actuarial Science) were also key to the inception and ongoing development of the ISIB program since the beginning. We especially want to thank so many excellent ISIB and graduate students, as well as their undergraduate mentors, who have helped us attract and recruit new students.

**Part VI**  
**Arguing for Full Inclusion**

# Statistics as a Tool for Equity



Mary W. Gray

**Abstract** By reviewing the history of the struggle for sex equity, a statistician relates how her professional experiences have played a role and urges others to use their knowledge and skills similarly.

As I was growing up, no one told me that girls don't study, like, or do well in math. No one made me feel that I did not belong—until my first class in graduate school where I was told that I should not be occupying a position that should go to a man. That's when I decided, "Don't get mad, just get even." How? How can we make use of whatever skills and opportunities we might have in order to do this? As statisticians, we can get the data and analyze them, but then what use can be made of our results?

First, "do no harm," the oath taken by physicians, should serve as a caution for statisticians as well. But we should go further and do some good, and in doing so, think of the imperative "Physician, heal thyself," dating back at least to the sixth century BCE. Here, I'll examine how the work of statisticians has had an impact, mostly favorable, on society, in particular in moving forward toward equitable treatment, focusing primarily on women, but generally applicable to everyone.

In the United States, we have a basic reliance on our Constitution for equitable treatment. The Fifth Amendment seems promising:

*No person shall . . . be deprived of life, liberty, or property, without due process of law.*

But it took the post-Civil War Fourteenth Amendment to extend this guarantee to at least some of those who had counted for only 3/5 of a person in the original document:

*No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty, or*

---

M. W. Gray (✉)

Department of Mathematics and Statistics, American University, Washington, DC, USA

e-mail: [mgray@american.edu](mailto:mgray@american.edu)

*property, without due process of law; nor deny to any person within its jurisdiction the equal protection of the laws.*

Those who thought that this meant women as well as men were soon disillusioned as it took until 1920 and the Nineteenth Amendment to secure for women even the right to vote. An attempt to complete the Constitutional guarantee of equality failed when the Equal Rights Amendment, first introduced to Congress in 1923 and approved by it in 1972:

*Equality of rights under the law shall not be denied or abridged by the United States or any State on account of sex.*

failed to obtain the required ratifications by 38 states by the original 1979 deadline or its 3-year extension.

Unmoved by, or perhaps actually in support of, the inequities that continue to exist, most recently a legislative committee in Virginia failed to bring the issue to the floor for what was expected to be ratification by the 38th state. It should be said that there is controversy regarding the existence of a deadline and the effect of subsequent withdrawals of their ratifications by some of the 37 states who had concurred, but finally having the 38th ratification would have been invigorating in the nearly 100-year battle to pass the ERA. Many, including statisticians whose work has demonstrated the need, continue to work to revive this move for this basic Constitutional protection.

## **Constitutional Guarantees**

In the 1896 decision *Plessy v. Ferguson* (163 U.S. 537), the United States Supreme Court held that “equal” was a pretty flexible concept, satisfied, in that case, by racially segregated railway carriages. However, the court in *Brown v. Board of Education* (397 U.S. 483 (1954)), faced with massive amounts of statistical evidence that separate education could never meet constitutional standards of equality with respect to race, overruled *Plessy*. Subsequently, slowly, one by one, cases demonstrated that the widespread inequality on the basis of sex could also be successfully challenged. First, evidence was provided that women could administer estates as effectively as men (*Reed v. Reed*, 404 U.S. 71 (1971)). Then, striking blows for equity for men as well as women, the Court found that male spouses of female military officers were entitled to the same benefits as female spouses of male officers (*Frontiero v. Richardson*, 411 U.S. 677 (1973)), that widowers should not be denied the survivor benefits the Social Security Act gave to widows (*Weinberger v. Wiesenfeld*, 420 U.S. 636 (1975)), that men should be able to drink 3.2 beer at the same age as women (*Craig v. Boren*, 429 U.S. 190 (1976)) since data showed that barring them from doing so was not a justifiable way to try to reduce traffic accidents, and that men should have equal access to nursing education (*Mississippi University for Women v. Hogan*, 458 U.S. 718 (1982)). The recent film *On the Basis of Sex* highlights a lower court victory by Justice Ruth Bader Ginsburg, at

the time an attorney whose expertise was primarily tax law, securing the right for a never-married man to deduct payments for a caregiver for his mother from his taxes if the care was necessary in order for him to be gainfully employed (*Moritz v. Commissioner of Internal Revenue*, 469 F. 2d 466 (10th Cir. 1977)). The relevant provision of the tax code had permitted such a deduction only for women, widowers (defined in this case to include divorced or legally separated men), or men whose wives were incapacitated.

And since, as Justice Ginsburg has said, “The decision whether or not to bear a child is central to a woman’s life, her well being and her dignity,” the landmark *Roe v. Wade* (410 U.S. 113 (1973)), contributed to the march toward equality although decided not on the basis of equal protection, but rather on that of privacy, a rationale pieced together from concepts in the Bill of Rights, an approach thought mistaken by some.

There were, of course, cases where the benefit to women was more direct, but the Supreme Court did not accord to gender discrimination the same level of **strict scrutiny** applied to racial distinctions:

*The restriction must serve a compelling government interest, be narrowly tailored to achieve that interest and be the least restrictive means for achieving it.*

The Court came close in *Frontiero*, but in *Vorcheimer v. School District of Philadelphia* (430 U.S. 703 (1977)) finally settled on an intermediate level of scrutiny between the **rational basis test**:

*The law in question is rationally related to a legitimate government interest*

and strict scrutiny, failing to reverse the Third Circuit finding that separate *was* equal with respect to sex segregation in public high schools. Not until the Virginia Military Institute (VMI) case (*United States v. Virginia*, 518 U.S. 515 (1996)) did the Court find separate could not always be equal in the case of sex.

In a victory for the federal system, the Philadelphia case was brought again, this time under the Pennsylvania constitutional guarantee of equality. The case was settled but I was able to testify that handy as Italian might be for opera lovers like myself, offering it at Girls High did not constitute equality with the Calculus II available at Central High. Not only were the curriculum differences significant of course, but graduates of Central High enjoyed access to the political and business local community not shared by those refused admissions.

And then, there was *General Electric v. Gilbert* (429 U.S. 125 (1976)), where the Court declared that to exclude pregnancy from short-term disability coverage was not illegal since pregnant men did not get the benefits either. On the other hand, the pregnancy leave requirements in *Cleveland Board of Education v. LaFleur* (414 U.S. 632 (1974)) were so arbitrary and unrelated to any rational cause as to be impermissible.



## Legislation

The Fourteenth Amendment also called upon Congress and the states to pass legislation to implement the promised equality:

*The Congress shall have power to enforce, by appropriate legislation, the provisions of this article.*

And, indeed, legislation has been passed to that end. In 1963, the Equal Pay Act mandated “equal pay for equal work.” Ever since, there have been some unsuccessful efforts to expand to the United Nations Convention to Eliminate Discrimination against Women (CEDAW) (a convention of the United Nations never ratified by the United States) standard of equal pay for *equivalent* work, but in either case, who better than statisticians to determine “equality”? In long-lasting litigation, Northwest Airlines claimed the jobs of stewardesses (women) were unequal to those of men (pursers) because on international flights the pursers handed over relevant documents to the local official opening the plane door. This was eventually found insufficient reason for paying pursers more, especially as it turned out that on flights with no purser the task was performed by a stewardess, but the litigation lasted longer than the airline (*Laffey v. Northwest Airlines, Inc.*, 740 F. 2d 1071 (D.C. Cir 1984)).

The Civil Rights Act of 1964 broadly prohibited discrimination on the basis of “protected categories,” including sex, in employment (Title VII), public accommodations (Title II), education (Title IV), and federal financial assistance (Title VI). Under considerable grassroots and lobbying pressure, Congress came to realize that the goal of equal rights for women required that we have adequate access to educational opportunities and enacted Title IX of the Education Amendments of 1972 explicitly and in detail addressing sex discrimination with respect to students, faculty, and staff in any educational institution receiving federal funds.

For many years, litigation under Title IX focused on access by women and girls to athletics. I believe that my statistical evidence helped secure the victory of the plaintiff in *Cohen v. Brown University* (101 F. 3d 155 (1st Cir. 1996)), providing the capstone to such litigation. Recent Title IX controversies have focused on issues of sexual harassment. Although the traditional single-sex institutions were exempted from Title IX admission requirements, most have integrated. However, the issue of whether “separate but equal”—or maybe not so equal—is the best model for women and minorities remains controversial. In the case of women, there is abundant evidence chronicling the success of graduates of women’s colleges, but lacking the rigorous evaluation standards statisticians like to see. No one has devised an adequate clinical trial of the results of same-sex education.

Protection for other vulnerable populations came through the Age Discrimination in Employment Act (ADEA) (1967), particularly helpful to women whose careers may have been delayed because of family responsibilities, and the Americans with Disabilities Act (1990), which provides broad protection in employment, education, and public accommodation. Originally tenured professors, along with

pilots, law enforcement officers, and others were among those to whom the ADEA's ban on mandatory retirement did not apply. In 1994, Congress accepted the recommendation of the commission it had established, on which I served as a representative of faculty, to remove the exemption. I have mixed feelings about this action having resulted in my becoming vulnerable once again to being accused of occupying a position that should be that of another person, in this case, a young woman or man. However, given the current situation in higher education, more likely were I to leave it would be filled with a part-time or temporary faculty member or by an administrator of some sort.

Congress also passed legislation to remedy what it recognized as gaps in protection exhibited in Supreme Court decisions. The Pregnancy Discrimination Act was the result of extensive lobbying efforts after *General Electric v. Gilbert*. Through the interpretation of the Supreme Court in *Young v. United Parcel Service* (135 S.Ct. 1338 (2015)), the Act's scope was extended beyond the protections provided in Title VII. When Peggy Young became pregnant, she was forced to quit her job because her physician advised that she could not safely meet the requirement of being able to lift 70 pounds and UPS was unwilling to reassign her to a job where she would not need to, although others with disabilities were accommodated. Nine years later, she won the battle.

The Lilly Ledbetter Fair Pay Act (2009), the first bill signed by the newly elected President Obama, secured for women a right we long thought we had. I identify with Lilly Ledbetter, one of the important figures in the battle for equal pay as it continues in the twenty-first century, in part because she was born less than a week after I was. In 1979, she went to work in the Goodyear factory, at the same salary as similarly employed men. Over the years, in a practice with which many of us are familiar, her male co-workers received larger raises than she did, based in part on "merit" evaluations she claimed were discriminatory, until by the time she took early retirement in 1998 her co-workers were paid as much as 25% more than she. Ledbetter brought suit under Title VII, which has a provision that claims of discrimination must be filed no later than 180 days after the discriminatory action. Although she met the 180-day deadline with respect to her last paycheck, the Supreme Court (*Ledbetter v. Goodyear Tire & Rubber Co.*, 550 U.S. 618 (2007)) found that to be considered the claim had to have been filed within 180 days of the first discrimination in her salary, which had occurred many years earlier.

The decision was a huge blow to discrimination litigation. As an expert witness I have often traced the differences in salaries based on situations just like Ledbetter's, some where the victims of sex or race discrimination won, others where they did not, but in spite of defendants' claims similar to Goodyear's reliance on Ledbetter's having to file suit within 180 days of the first discrimination, never had the employers been successful with this defense. The Supreme Court ruling was especially crippling as often plaintiffs had not even known how their salaries compared with those of males until years after the discrimination first occurred. Fortunately, intense lobbying resulted in the restorative legislation so that each unfair paycheck can be considered an act of discrimination.

## Disparate Treatment/Disparate Impact

In the legal context, there are two categories of discrimination: direct and indirect or disparate treatment and disparate impact. To fail to choose a candidate for a position, a promotion, admission to a program, etc., because she is a woman (possibly because of misconceived stereotypes or just plain misogyny) is disparate treatment. But if a facially neutral concept results in fewer women being selected than would have happened by chance, that is disparate impact. For example, height qualifications for pilots disproportionately exclude many women and some minority males. Beyond the extent that the requirement could be justified as the business necessity of the pilots being able to reach the controls, this constitutes disparate impact discrimination. The seminal case (*Griggs v. Duke Power Co.*, 401 U.S. 424 (1971)) involved the requirement that power linemen be high school graduates and the disparate impact of graduation rates by race in North Carolina at that time; it was established that many men without such a qualification had served adequately, demonstrating that high school graduation was not a necessity for the position. Of course, back then no one was thinking about women in the job.

Because it is up to statisticians to demonstrate to the courts what impact is “disparate,” it has become important in employment and other contexts that we perform this role adequately.

There are other guarantees than those already discussed, guarantees that can be tested through the use of statistics. The Sixth Amendment ensures:

*In all criminal prosecutions, the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the State and district wherein the crime shall have been committed,*  
...

The relevant phrase, of course, is “impartial jury.” The post-civil war amendments meant that constitutionally no longer could race explicitly be used in jury selection; then *Strauder v. West Virginia* (100 U.S. 303 (1879)) successfully challenged a requirement that for a juror to be eligible to serve, the juror’s grandfather had to have been eligible for jury selection. Subsequently, statistics began to be used to judge whether there had been de facto exclusion by race at, first using a simple comparison of the eligible population to that of the jury venires. Finally, in *Castaneda v. Partida* (430 U.S. 482 (1977)), a 79% to 39% comparison was also described as having an only 1 in 10,140 probability of having occurred by chance, and that the difference between the observed and expected values for the representation of minorities was 29 standard deviations. Unfortunately, the guidance in this and other cases regarding statistical significance found standard deviations of at least 2 or 3 to be indicative of prima facie evidence if not dispositive, leaving it to subsequent decisions to point out the considerable difference in the probability between two and three. At the same time, the statistical analysis in employment and other cases such as *Hazelwood School District v. United States* (433 U.S. 299 (1977)) became more sophisticated, fostering a rumor that one of the justices had a law clerk with statistical training. In a circuit court case (*Palmer v Shultz*, 815 F. 2d 84 (DC Cir. 1987)) describing discriminatory promotional opportunities for

women in the foreign service, there is a discussion of the appropriateness of  $p$ -values in a one- or two-tailed context. The introduction of probability analysis led to increasingly sophisticated analysis, not only in discrimination cases but in areas such as anti-trust, patent, and environment.

Although the issue in the death penalty cases has usually been centered on the composition of the jury venire, purposeful discrimination in the preemptive (without cause) challenge of prospective trial jurors has also been found to be illegal (*Batson v. Kentucky*, 476 U.S. 79 (1986)). There are a number of studies showing substantial racial disparities in death penalty sentencing related, perhaps at least in part, to the jury selection issues just discussed. In particular, the Baldus study *McCleskey v. Kemp*, (481 U.S. 279 (1987)) employed models with as many as 230 variables, with one with 39 variables showing that defendants convicted of killing a white victim were 4.3 times as likely to be sentenced to death as those found guilty of killing a black victim and that black defendants were 1.1 times as likely as white defendants to be sentenced to death. However, the court held that the statistics were inconclusive absent some evidence of discrimination specific to the McCleskey case. There also continue to be complex statistical studies supporting or refuting the claim that the existence of the death penalty deters crime, studies discussed by the courts, but generally, they have not played a role in their decisions.

For a time, the Supreme Court decision *Furman v. Georgia* (408 U.S. 238 (1972)) resulted in a moratorium on the death penalty until the court appeared satisfied that the arbitrariness had been resolved in *Gregg v. Georgia* (428 U.S. 153 (1976)) so that the death penalty continues to muster court approval in spite of the Eighth Amendment's admonition,

*Excessive bail shall not be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted,*

the declaration of Justice Harry Blackman in his dissent in *Callins v. Collins*, (510 U.S. 1141 (1994)), "I no longer shall tinker with the machinery of death," the isolation of the United States as a country with the death penalty, and contemporary litigation challenging the humaneness of various methods of execution.

The use, or sometimes misuse, of statistical inference as evidence continues, of course, but in the context of ambivalence in the courts as to what constitutes discrimination, or for that matter what is the remedy. Generally, the goal is to return the victim to the position that s/he would have been in absent discrimination. That can be inadequate can be seen in a recent Supreme Court decision (*Flowers v. Mississippi*, decided June 21, 2019), once more remanding in line with the *Batson* decision, a situation where the same prosecutor tried the case six times, the case being previously remanded after successful appeals of four guilty verdicts (and two hung juries); whether there will be a seventh trial is not yet known.

Admission of statistical evidence is generally regulated by the *Daubert* standard (*Daubert v. Merrell Dow Pharmaceuticals Inc.*, 509 U.S. 579 (1993)), under which the factors that may be considered in determining whether the methodology is valid are: (1) whether the theory or technique in question can be and has been tested; (2) whether it has been subjected to peer review and publication; (3) its known or

potential error rate; (4) the existence and maintenance of standards controlling its operation; and (5) whether it has attracted widespread acceptance within a relevant scientific community. Intended to keep junk science out of court, the application of *Daubert* has also led to disputes about controversial statistical methodology. However, the reluctance of some judges to admit evidence employing Bayesian techniques is more likely to be due to the misunderstanding of “priors.” In “doing good,” the adherence to the standards of ethical practice as well as legal and statistical principles is paramount; in particular, although the United States justice system is essentially adversarial, it is the attorneys, not the expert statisticians who should be the advocates.

## **Pensions and Insurance**

In examining employment discrimination in the activism of the 1970s and 1980s, many observed that among the most impoverished were older women (and some not so old single mothers) who had relied on a husband with a good job and enviable pension plan—only to find that its benefits had been signed away by the agreement of their spouse to a larger pension for the worker in exchange for eliminating survivor benefits for the dependent spouse even if there were also children still dependent. Lobbying efforts produced the sign-off requirement that no money can be dispersed from a retirement account without the consent of the spouse and the requirement that survivor benefits must be provided for (Retirement Equity Act of 1981). With some labor union and civil rights support, we had located struggling widows of some West Virginia mine employees whose husbands had not provided for survivor benefits; their testimony provided a poignant setting for consideration of the legislation. Now, whenever I am asked to show that I am a widow in order to have access to retirement plan funds, I think of the power of story-telling (along with statistics) to change the law; it is too bad that it does not happen more often.

But what if there is no spouse with a nice retirement plan or no husband at all for the woman whose life had been one of unpaid labor? To qualify for Social Security benefits, even now under attack by some politicians, at least a minimum record of employee contributions from a covered job was required, thus excluding many women. A little more digging through available data found many women in religious orders whose communities were hard-pressed to provide for them in their old age. This time we focused our lobbying efforts on a few crucial Congressmen who were convinced to help by the stories of the fondly remembered Sisters who had guided their early Catholic education.

Once we had addressed—if admittedly not solved—the problem of women whose major employment had been unpaid throughout their lives, what about women with paying jobs – even if they were paid only 63% of what men were paid? Groups focusing on economic equity launched a major effort for expansion of private pensions, given the inadequacy of Social Security provisions for many even with long employment records, especially those in low-paid jobs. Many

employees of public entities or large corporations were covered by retirement plans, complex and limited though they might have been, sometimes requiring voluntary participation although other times automatic.

For example, my own employer had—even when I started there 50 years ago—a voluntary plan where the employer would match employees' contributions up to a certain amount. But many employees, women and men, were not contributing, feeling that the required contribution from their own meager salaries could not be spared for the prospect of a pension that might be 50 years in the future. To counteract this reluctance, we instituted an educational campaign urging the employees not to let the matching contributions lie on the table. Statisticians at many institutions, particularly at many private universities covered by the TIAA-CREF plan, first established by Carnegie to support retired professors but later funded by employers and employees, could be enlisted to explain the growth potential from compound interest on early career contributions (even without considering possible market growth).

Once we could convince people to participate, we had the money going in, but what about when it comes out? Title VII of the Civil Rights Act of 1964 prohibits discrimination on the basis of gender in benefits as well as salaries. The Supreme Court in *City of Los Angeles Department of Water and Power v. Manhart*, (435 U.S. 702 (1978)) held that requiring women to contribute more to a pension plan than men in order to get the same benefits was a violation of Title VII. The excuse of the City of Los Angeles that women lived longer than men and hence their total payout would theoretically be equal to that of men, whose lesser longevity was in many cases based in part on more extensive participation in risky behavior like smoking, drinking, reckless driving, and violent activity, was rejected. Clearly, actuarial equality was not practical equality when it came to addressing retirees' need to cover their daily expenses.

If the principle of “unequal in, equal out” is illegal, you would think that “equal in, unequal out” would also be illegal. Not so maintained operators of pension funds like Arizona Governing Committee and TIAA-CREF, which claimed that the 15% more in monthly benefits paid to male retirees than to similarly situated females with the same accumulations in their annuity plans was not illegal. When I complained to TIAA-CREF about the inequity in my projected payout, they pointed out that the death benefits in life insurance plans discriminated in favor of women (by no means nearly as much as the annuity plans did in the opposite direction), and in any case, the discrimination was on the basis of longevity, not sex. When I asked whether I was guaranteed a longer life than male participants, I was patronizingly told that I just did not understand statistics.

Challenged that they were not paying more to African American retirees whose life expectancy might be less than that of the majority of retirees, their response was to point out that they had no record of the race of participants. The suggestion that a similar solution to the gender issue that would save millions in litigation costs might be in order was laughed out of court. Literally “out of court” as by this time (late 1970s) there were a number of cases in court; in particular, Nathalie Norris had sued the Arizona Governing Committee (463 U.S. 1013 (1983)) and Diana Spirt

had sued TIAA-CREF and Long Island University (691 F. 2d 1054 (2d Cir.1982)). As an expert for the Equal Employment Opportunity Commission in support of Spirt, I spent some time in “settlement” talks with a barrage of TIAA lawyers and the indomitable Ruth Weyand, widely recognized for her earlier efforts in *General Electric v. Gilbert* and other women’s rights litigation. While the case was not settled in the talks, they provided me with a great personal benefit. At one point, a TIAA attorney complained to me, “You may understand statistics, but you don’t understand the law.” How hard could that be I thought? So I went to law school, which I loved, while continuing to teach, for several years chairing my department, and keeping involved in equity issues. I subsequently got engaged in the Norris case, which was moving faster than the Spirt litigation, but not so fast that by the time it got to the Supreme Court I had not qualified as a member of the Supreme Court Bar and could write an *amicus* brief as well as helping Norris’ attorney with the statistics.

Working with the distinguished economist, the late Barbara Bergmann, we made use of my favorite argument. Consider a cohort of 1000 men and 1000 women aged 65. The distribution of the death ages of each is roughly normal, but the mean is lower for men than for women. However, 86% of the distributions can be matched; a man dies at 66, a woman dies at 66; a man dies at 89, a woman dies at 89, etc. Left are roughly 7% of the original cohort who are men who die early, unmatched by women and 7% who are women who live longer, unmatched by men. Observe that it is not that the 7% of men die before all the women, but rather only that they are unmatched by individual women. Similarly, the 7% in the other tail of the distribution are women whose long lives are unmatched by individual long-lived men. The importance of this view is that it shows that 86% of the group are “similarly situated,” the standard for unequal treatment to be illegal.

I am a theatre frequenter, especially when I manage to get to London, but with all the spectacular performances by the stars of the past 50 years, what I most remember is that during the interval of the matinee on the day the decision in *Norris* was to be announced, I ran from the theatre to Waterloo Station, the nearest place from which I could make an international payphone call, to get the result. How easily we can forget that mobile phones have not always been available.

But *Norris*, relying on Title VII and the Equal Pay Act settled only the employment-related pensions issue even though we got far more than we expected. Many plans, including TIAA-CREF, rather than adjusting payouts to the lower female level or a midpoint, adjusted all payments to the male level and although the decision applied only to funds invested prospectively, applied the new levels to existing funds. It seems that reserves had been established in anticipation of equity’s being mandated.

This was a big gain for women academics (including, of course, statisticians) because the women who were retired by 1983 had taught primarily in small colleges, particularly women’s colleges, where the salaries were not very high for anyone and were often even less for women and the contributions to pension plans were correspondingly meager; a 15% increase could mean a lot. But wait, as they say in TV ads promoting the latest “bargain,” statisticians, especially women statisticians,

have had something to say about this as well. If only we had by now been as successful with salaries as we were with pensions.

The 70s and 80s were a busy time for me. As there were few women's rights activists who felt comfortable with numbers, I was often called on when concepts needed explanation for congressional court testimony, lobbying, and press briefings. Even after *Norris* almost all insurance plans and annuities not employment related were discriminatory, some in favor of women, some against men as in life insurance or against young men as in automobile insurance, others, like annuities and health insurance, against women. Whereas there were justifiable non-discriminatory reasons for the disparities, they were often greatly exaggerated. In one state, we found that auto insurance rates for a male driver under 19 with a clean record were much higher than for a driver with two DUI convictions. And although rates for women's health insurance might be understandably higher during child-bearing years, the statistics showed that the gender effect shifted at older ages but the insurance rate inequities did not. Insurance is for the most part regulated by the states so that the struggle for change was many faceted. My most memorable efforts included testifying to the state legislature in Montana and thinking I would not make the next day's hearings in Salem, Oregon, because a blizzard was causing all flights out of Helena to be canceled only to be driven in the storm to the other end of the state (and Montana is a big state) to get a plane—that followed the snow plow down the runway—to Spokane where I could change for a connection to Salem. I had left several insurance company lobbyists in Helena whose colleagues, dispatched from Washington to Salem, were quite surprised to encounter me there. We needed more statisticians actively engaged—and still do.

## Salary Studies

Money isn't everything, but it is a lot, especially given the prestige which can surround the highly paid. Women's wages as a percentage of men's have crept up from the 63% widely quoted in the 70s, but not to 100%. Whatever figure is used for comparison, it has always been discounted as not reflecting differences in years of experience, education, hours worked, type of position, and other factors. But as statisticians, we know how to control for such factors. The idea of using regression models to study salaries in general was introduced earlier (Finkelstein, 1980), but a large number of colleges and universities used (or in some cases misused) a methodology pioneered by Elizabeth Scott from her examination of faculty salaries at her home institution, the University of California at Berkeley, and widely publicized by the American Association of University Professors (AAUP) (Scott, 1977) and others. Using the methodology based on available data on education and experience of faculty, institution after institution, employing local or imported statisticians, would find that if these were controlled for, there would remain an unaccounted-for difference whether the women's salaries were regressed on a model constructed from the data on men's salaries or included with the men's in a single



model. Often the remaining difference was said to be based on “merit,” but when challenged, employers were usually at a loss to explain in what way women as a whole were less meritorious than men.

Having myself used the methodology at more than 50 universities, I found only one where, controlling for education, experience, and field, there was not a difference in favor of men, generally by 10 to 15% of the women’s mean salary. Such results were usually statistically significant at least at the 5% level. Attorneys and the finders-of-fact in litigation, be they judges or juries, have problems understanding *p*-values and hypothesis testing in much the same way as do students in basic statistics courses, a fact to keep in mind when presenting evidence. But gradually improvements in the power of statistics to move toward equity have resulted.

In the case of salary studies as in many applications of statistics, that the results suggested discrimination was unpalatable to many; the common response was twofold—let’s reduce the sample size or add more variables. The theory was promoted that there was no general salary policy across the institution so that the source and nature of discrimination couldn’t be pinpointed or was not the same everywhere—better to run separate studies school by school (arts and sciences, business, engineering, etc.) or even by departments. This is a common ploy, also used elsewhere in litigation. Most employment and education discrimination cases involve groups of employees since the benefits in a single case would not justify the legal expense involved. Thus, a *class* is certified with one or more named plaintiffs, under federal regulations generally specifying that the class can be properly defined and that its members satisfy the ascertainability, numerosity, commonality, typicality, and adequacy requirements as well as at least one of the following: that separate adjudication would risk decisions inconsistent with or dispositive of other class members’ claims, that declarative or injunctive relief would be appropriate for the class, declaratory or injunctive relief is appropriate based on the defendant’s acts with respect to the class generally, or common questions predominate and a class action is superior to individual actions. Thus, when Norris challenged the Arizona Governing Committee, a class of retirees was certified, and Cohen was the class representative for victims of Brown University’s discrimination. The leading case involving women’s salaries is *Wal-Mart v. Dukes* (564 U.S. 338 (2011)) where the Supreme Court reversed a lower court’s certification of the class of Wal-Mart’s 1.6 million women employees, leaving the women only the possibility of litigating on the basis of a more regionally or job description defined class action. Class actions of university faculty have met with mixed success but the techniques of limiting the class have been widely used to prevent meaningful settlements involving large numbers of women even when the challenges have been successful.

Also effective in seeking to make salary differences disappear is the inclusion of faculty rank as an explanatory variable since male professors dominate among the highly paid full professors and women cluster in lower, less well-paid ranks; similar situations abound in government and industry. Of course, if there is discrimination it has likely affected the promotion process so that rank is a biased variable.

Nonetheless, frequently defendants get away with its inclusion, often with the result of wiping out most if not all sex-based salary differences.

However the model is manipulated, a residual difference may remain. How to structure a remedy (aside from what is likely to be a short-lived injunction against discrimination)? The usual method has been to find the few women faculty with the largest negative residuals and give a raise of a few thousand dollars to each of them. Institutions that conduct a more nuanced study of possible discrimination have found that the women most discriminated against are those with the highest salaries; the male “stars” are richly rewarded, the female “stars” not so much. But the point is that modeling of salaries identifies a system effect rather than addressing individual salaries. In a follow-up (Scott & Gray, 1980) to her kit, Scott and I tried to convince those who used the models that the appropriate remedy is a statistical one, namely give the same raise (dollar amount or percentage) to each woman.

Salary studies continue to be used and continue to demonstrate, whether at universities, government, or industry, that it is important to have more women in high-level positions, particularly those in decision-making roles. A recent study showed that among major firms there were more CEOs with the first name “James” than there were women. When I started out, the market for PhDs in mathematical sciences was such that employers would take anyone, irrespective of gender, at least in initial positions, so I did not have to suffer the taunt of being told that I had my position only through affirmative action as did some of my successors. But what is clear, is that it is affirmative action that has enabled qualified women to be less likely to be overlooked in admission, hiring, promotion, and compensation considerations but that there is still a long way to go. Sending out fake resumé has been used for at least 50 years (Fidell, 1970) but continues to show that both men and women devalue achievements attributed to identifiably female applicants (González, Cortina, & Rodriguez, 2019) so clearly vigilance is still needed. The British term is “positive discrimination,” but discrimination implies biased decision-making whereas affirmative active seeks rather to level the playing field, by assuring that women are on it.

## **I’m Not a Gentleman**

I originally switched my interest in research and teaching from abstract algebra to statistics when way back in the 1970s I found myself being asked to judge whether the process for the selection of White House Fellows was discriminatory, consulted about the fairness of the draft lottery, and then found the message from TIAA-CREF about my own retirement funds. I always knew that I was not going to prove Fermat’s Last Theorem or save the world through mathematics, but I hoped that I could do something useful more closely connected to the real world using statistics. Now I am looking at the statistics behind a tenure case at a large state university, examining a study of the performance of transgender athletes, still working on pension benefits for the outsourced service employees of my university,

consulting on the training of expert witness statisticians, reviewing statistics on refugees around the world, and advising young women on their careers and how to continue the struggle. Meanwhile, thousands of statisticians are at work on many projects to make a better world. One important contribution to improving health care for everyone has been for statisticians to observe that the results from clinical trials whose participants were all adult white males are not necessarily applicable to others.

The message is that improvement needs sustained group effort. My first encounter with advocacy within my profession led to the one incident in my life about which accounts appear frequently. Mathematicians, primarily anti-war and civil rights activists, were complaining about the lack of interest or action on increasing the diversity of the profession; talk among ourselves appeared unproductive so I decided the case should be made at a meeting of the governing council of the American Mathematical Society. I was stopped at the door by the society president who told me that only council members were admitted to the meeting. I had done a little homework and so was able to point out that the by-laws said that council meetings were open to all members of the society, not that only council members could attend. "Oh," he replied, "it's a gentlemen's agreement." "I'm no gentleman," I announced as I settled down to stay. In truth, it was pretty boring, but the experience led me to activism on a number of issues—discrimination, the professional job market, the ethics of accepting support for research from various organizations—activism that got me elected to the council and later as vice-president of the society where I could liven things up. I had to endure comments from fellow council members like, in defending blind refereeing, "How would we know that a paper was any good if we didn't know who wrote it?"

A group of like-minded mathematicians fed up with the male dominance of a large conference decided that we needed our own organization to push the agenda of women's rights. A table in our spare bedroom became the headquarters of the Association of Women in Mathematics (AWM), later changed to Association *for* Women in Mathematics in recognition of the broad support we needed, and received (in particular, from my late husband Alfred Gray, and my inspirations in activism, Chandler Davis, and the late Lee Lorch). Next year will be the 50th anniversary of the AWM, whose achievements are many. A review of the program of annual meetings may still not reveal the gender diversity we'd like in research and teaching, but now there is a queue at the women's restrooms (an issue that may be resolved with the spread of all-gender facilities). We know that when women organize conferences or panels there are likely to be more female participants than otherwise. AWM has established a tradition of sponsorship of research conferences in mathematics, statistics, and mathematics education; awards for undergraduate research; the Emmy Noether and other lecture series; and participatory events such as Sonya Kovalevsky workshops for high school women. It has been built on the legacy from the early dissidents who became agitators and then supporters of positive actions, but it now advances the role of women in mathematics under the direction of new generations of activists.

Just before AWM was started, women in statistics recognized the same problems, but focused more widely on those working in government and business rather than academe. With my increasing self-identification as a statistician, I was happy to get involved in the ongoing efforts of the Caucus for Women in Statistics. Both groups feel that their long-term existence and success in comparison with women's groups in many other disciplines are due to their cooperation with, but independence from, the dominant professional groups in the field.

There is much discussion of implicit or unconscious bias in gender and race discrimination these days, but to me, explicit or conscious bias still exists and needs to be addressed. Due in part to the efforts of AWM and the Caucus a distinguished researcher will probably no long announce in a meeting his reason for continuing to have only white males among the tenured faculty in his department: "We once hired a woman but her research wasn't very good," but he may still be consciously thinking that he will not be a party to trying again. The thousand cuts that the victims of any form of discrimination suffer may not always heal, but concerted efforts to prevent their repetition ought to be the goal of statisticians using the skills and tools they possess.

## Action Points

### *Learn*

It has been conjectured that a majority of born-in-the-US citizens would fail the exam that must be passed by those being naturalized. Perhaps with some study, they would succeed, but the sad fact is that all of us, no matter where born—and that includes statisticians—are woefully ignorant of how our government works. There are legal protections for women's rights—and for all rights—but to garner their benefits it certainly helps to be aware of what these perquisites are. Not everyone should be a lawyer, nor should everyone be a statistician, but no matter what one's profession might be there are basic legal principles with which everyone should be familiar. So learn your rights and then work hard to see that they are implemented widely and fairly.

### *Vote*

However, there is room for improvement in the legal system, starting with the fact that in the 100 years that all US women have had the right to vote, it has not been possible to enact the Equal Rights Amendment, the addition to the constitution that would decree that equal rights *shall not be denied on account of sex*. Recently in Virginia, the lack of the vote of one more legislator prevented ratification from even

getting out of committee. Even if that situation is remedied by the results of the next election there are remaining hurdles in the process. So if you seek change, first and foremost exercise your right to vote that is guaranteed under the 19th Amendment. Find out what the positions of candidates are and support those who favor what you favor.

## *Organize*

And organize others to do the same. If there is not a suitable candidate, find one, even if that means looking in the mirror. Congress, statehouses, state legislatures, city and county governments all need more members attuned to women's rights—how to gain them and how to protect them. Political action can take the form of support of candidates or of basic principles, but politics are what get causes implemented. Helping supporters get elected and keeping their attention on your issues is how laws get enacted and how change gets implemented.

## *Serve*

If you are the candidate elected, naturally you need to keep your focus on how and why that happened, but there are many other ways to serve to advance and maintain rights for women—and don't forget that should be for ALL women, not just for those who look and act like you do. Lawyers have an ethical obligation to do pro bono work. I have long maintained that the same should be true of statisticians. Cases advancing women's rights have been won because of data gathered and analyzed as we have described here, but there are always new areas that need to be explored, rights that should exist but need to be secured through careful assembling of evidence to promote legislation. And if there is to be justice for all, someone may need to provide pro bono statistical help as well as that for which we might be paid. Of course, important as the law is, there are plenty of other ways to serve, mentoring our successors ought to be part of the leadership others have helped us to achieve.

## **References**

- Fidell, L. S. (1970). Empirical verification of sex discrimination in hiring practices in psychology. *American Psychologist*, 28(2), 1094–1098.
- Finkelstein, M. O. (1980). The judicial reception of multiple regression studies in race and sex discrimination cases. *Columbia Law Review*, 80(4), 702–736.
- González, M. J., Cortina, C., & Rodríguez, J. (2019). The role of gender stereotypes in hiring: A field experiment. *European Sociologist*, 35(2), 187–204.

- Scott, E. L. (1977). *Higher education salary evaluation kit*. Washington, DC: American Association of University Professors.
- Scott, E. L., & Gray, M. W. (1980). A statistical remedy for statistically identified discrimination. *Academe*, 26, 174–181.

# Inclusion of Individuals with Disabilities



Allan R. Sampson

**Abstract** The need to develop an environment that is fully inclusive of individuals with disabilities is legally and morally compelling. Full inclusion of individuals with disabilities in the workforce generally—and in statistics specifically—benefits not just individuals with disabilities, but everyone in the workforce and in the field.

## Introduction

This chapter deals with the importance of building an environment that is fully inclusive of individuals with disabilities. While the issues associated with ensuring such an environment may at times be complex, the need to develop such an environment is legally and morally compelling. Full inclusion of individuals with disabilities in the workforce generally—and in statistics specifically—is essential. It benefits not just individuals with disabilities, but everyone in the workforce and in the field. To create this necessary environment, there are two types of technical considerations: (1) the legalities and realities of what constitutes a disability and (2) the potential costs involved in the actual steps that may be needed to create an accessible environment. The basis for many of the civil rights for individuals with disabilities is the federal Americans with Disabilities Act of 1990 (the “ADA”). The enactment of this legislation is a relatively recent occurrence in our national civil rights movements, and the full meaning and application of the ADA and its later amendment are still being established, sometimes by the courts. However, the intent of this landmark legislation has always been to create a society that values and fully includes individuals who have disabilities.

This chapter begins with a brief discussion of “disability” generally and a short history of rights for individuals with disabilities. To personalize this history, the author also briefly describes his own experiences as a person who has had a

---

A. R. Sampson (✉)  
Department of Statistics, University of Pittsburgh, Pittsburgh, PA, USA  
e-mail: [asampson@pitt.edu](mailto:asampson@pitt.edu)

disability for many years. The roles that two professional societies of interest to statisticians, the American Statistical Association (the “ASA”) and the American Association for the Advancement of Science (the “AAAS”), have played in the advancement of professional opportunities for individuals with disabilities are described. At the present time, many organizations and corporations measure and report the diversity of their employees and these measurements now often include—and should include—people with disabilities.

The heart of this chapter describes how we as individuals and organizations can foster inclusion of individuals with disabilities. There are multiple steps involved in building such an environment and many of the related major issues are presented in this chapter. Concluding this chapter is a discussion of behaviors related to disability and some final remarks and action plans.

It is important to emphasize that this chapter only introduces how all of us might proceed to further our organization’s goals to foster full inclusion of individuals with disabilities. This subject has many complexities and is still evolving. However, the objective is clear—**full inclusion**. The challenge to the reader is to understand the basic issues involved in effecting inclusion and to obtain the necessary further information to advance inclusion in their environments.

## Background and Brief History

The Centers for Disease Control and Prevention (CDC, 2017) defines a disability as “any condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions)”. According to Kraus, Lauer, Coleman, and Houtenville (2018), based on the American Community Survey, 10.6% of American adults aged 18–64 were reported as having a disability in 2016. Furthermore, in 2016, among individuals aged 18–64 with a disability and living in the community, 35.9% were employed, while in comparison 76.6% of Americans aged 18–64 without a disability were employed. Employment percentages varied among different types of disabilities. There were six types of disabilities measured by the American Community Survey in 2016. Among all Americans aged 18–64, the percentages of individuals with various disabilities were: hearing (2.0%), vision (2.0%), cognitive (4.5%), ambulatory (5.1%), self-care (1.9%), and independent living (3.8%). (Note that these percentages total more than 10.6% as some individuals responded as having two or more disabilities). Among the individuals aged 18–64 who reported having each of the six noted disabilities the employment percentages were, respectively, 51.7%, 43.5%, 26.3%, 24.8%, 15.5%, and 17.0%. There appear to be no comparable data for individuals with disabilities in relationship to employment in the statistical sciences.

The first national civil rights law protecting individuals with disabilities was Section 504 of the 1973 Rehabilitation Act which applied to “any program or activity receiving federal financial assistance”. It protected “qualified individuals” from



discrimination based on their disability. For purposes of employment “qualified individuals with disabilities are persons who, with reasonable accommodation can perform the essential functions of the job for which they applied” (OCR, 2006). To more generally combat “discrimination against individuals with disabilities”, the U.S. Congress passed Public Law 101-336 (1990), better known as the ADA. The ADA is a civil rights law that prohibits discrimination against peoples with disabilities with regard to employment, state and local government public services, public accommodations and telecommunications, as well as in a number of other related items. In terms of employment, there is a requirement for reasonable accommodations both in terms of physical facilities and job structure. The ADA does provide that accommodations requiring “undue hardship” need not be done, where the term “‘undue hardship’ means an action requiring significant difficulty or expense”. The practical interpretation of undue hardship often is determined on a case-by-case basis, taking into consideration the employers’ particular circumstances. A similar terminology applies to public accommodations.

In 2009, the ADA Amended (the “ADAA”) law (Public Law 110-325, 2009) was passed. The ADAA broadened the coverage of individuals under the amended law. The motivations for this amendment were court findings under the ADA that took a quite narrow view of the covered individuals.

## **Sixty Years of Personal Experience**

Shortly prior to the public availability and widespread use of the Salk polio vaccine, I contracted polio, which resulted in my needing to use crutches and a wheelchair for mobility. During the more than six decades since, I have experienced first-hand a long period of dynamic changes with respect to the legal standing of people with disabilities and the public perception of disabilities and peoples with disabilities.

As a child, my parents’ committed efforts and a supportive community helped me to succeed in my education. I graduated high school on time, even though I was unable to attend school for a year and missed halves of several other years. I was lucky enough to have chosen UCLA for my undergraduate university, without knowing at the time that UCLA had extraordinary support services for individuals with physical difficulties. I later learned that these were available because there was a large VA hospital near UCLA and many veterans with disabilities were treated there due to the great weather. Because UCLA was very close, it was the school of choice for their studies during their rehabilitation. As an undergraduate, I had available ramped access to most buildings, special parking permits and a central office which handled with ease any special access issues I had. Not surprisingly these experiences created certain expectations for me.

Beyond the campus environment, there were less supportive experiences. One that still stands out was when my parents asked me to use the state vocational rehabilitation services in order to help pay for my UCLA education fees. After I went through the process, the state “guidance counselor” whom I had told my goal

was to become a college professor called my parents one evening. He suggested that they discourage me from this goal because someone with my disability would not be able to eventually find such a job. Needless to say, my parents were aghast with this suggestion and totally ignored it.

After UCLA, I attended Stanford University for graduate school. Although Stanford wasn't quite as accessible as UCLA, I still had a largely positive experience on campus. Sequoia Hall, home of the statistics department, was ramped due to James Boen's having previously spent time there. And the campus as a whole was manageable in a wheelchair due to the lateral layout of the "quad". In a later year of my graduate studies, I had applied for a summer job at a government sponsored research lab. Several fellow students had worked there during previous summers and enjoyed it. My filled-out application form was returned to me saying the lab could not offer me a job. But I did notice in my returned application form, the question regarding disability for which I had replied openly now had been highlighted in yellow. At the time, I wondered why this was the only part of my application that was highlighted.

These early experiences all occurred prior to the 1973 passage of Section 504. From that time on universities and colleges receiving any federal money had to make their facilities, as well as their employment practices accessible. The general impact of this requirement took time to be felt, but there began a noticeable difference in official responses of institutions—something that I had begun to feel.

At this time, professional scientific organizations were beginning to form committees to address the broad issues to make their society more accessible for individuals with disabilities. Some societies had become aware that barriers to their various scientific professions existed for individuals with disabilities and that these barriers could be modified, if not removed. The earliest efforts in this regard of which I am aware was by the American Association for the Advancement of Science (AAAS) which formed the Project on Science, Technology, and Disability in 1975—a project that is still active. The American Statistical Association (ASA) prompted by I. Richard Savage during his presidency in 1984 initiated discussions about forming a similar type of committee. In 1985, ASA President John Neter and the Board of Directors approved the formation of the Ad-Hoc Committee on Statistics and Disability and in 1989, it became a permanent committee. Richard Savage had involved me in his efforts and I was happy to accept an appointment as first Chair of the ad-Hoc Committee. This committee began with a number of foci, including barrier mitigation, improvement of federal data collection concerning peoples with disabilities and promotion of the profession of statistics as an excellent one for individuals with a disability, the later focus being still important now. One of the early accomplishments of this committee was its work with counterparts of the AAAS to organize an NSF-funded "Workshop on the Demography of Scientists and Engineers with Disabilities" held in 1988 (Sampson et al., 1991).

By the time the ADA was enacted, I could see some positive changes in the public's perceptions of individuals with disabilities. With its passage these changes accelerated, so that disability has now entered contemporary conversations about diversity and inclusion. We also now recognize that diversity with regard

to disability has value to our organizations and is not just a legal obligation. More fundamentally, providing full participation in our society for all people with disabilities is seen as a human right.

## Disability and Diversity

It has become part of our social fabric that having a diverse environment brings value to an organization. And during the past decade, diversity has become defined to include individuals with differing abilities, or disabilities. The U.S. Department of Labor's Office of Disability Employment Policy (ODEP) in their publication *Building an Inclusive Workforce* (ODEP, 2019b) notes.

When it comes to doing business, including workers with disabilities offers a competitive edge. By incorporating people with disabilities into their human capital strategies, employers expand their pool of talent, skills, and creative business solutions . . . Today more than ever, businesses need people with the ability to adapt to different situations and circumstances. And perhaps more than any other group, people with disabilities possess precisely these attributes. On a daily basis, people with disabilities must think creatively about how to solve problems and accomplish tasks. In the workplace, this translates into innovative thinking, fresh ideas, and varied approaches to confronting challenges and achieving success.

Progressive corporations produce publically available documents addressing diversity within their organization. For example, Facebook publishes an annual diversity report. In its 2018 Diversity Report (Williams, 2018), there are extensive data and programmatic information about gender and racial minorities. Facebook acknowledges that “diversity isn’t only about gender, race and ethnicity”. As such it reports, among other data, percentages of “US employees who self-identify as LGBTQ+ or Trans+”. Notably it reports that Facebook was awarded a “100% rating on the USBLN Disability Index”. The Disability Equality Index<sup>®</sup> is a joint initiative by the American Association of People with Disabilities and Disability:IN and is based on a lengthy questionnaire which scores a company on “their disability inclusion policies and practices” (DEI, 2019). From my viewpoint, this measure documents well the corporate policy and specifics that have been put in place to foster recognition and employment for individuals with disabilities. However, it fails to address the bottom line: Is the corporation successful in attracting and retaining employees with disabilities?

## Fostering an Inclusive Environment

While the focus in this chapter is primarily on the workplace, it is important to keep in mind that for many of us, our environment includes not only our employees and colleagues, but also our customers, clients and the public more generally.

Some aspects of an inclusive environment for individuals with disabilities naturally happen because good designs and policies for an entity benefits all. This can be achieved by employing universal design throughout. As well described by the Center for Excellence in Universal Design (2019), “Universal Design is the design and composition of an environment so that it can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability.” For instance, we should all want to have uncluttered pathways, devices operable and hung so that all individuals can reach and operate them, and floor surfaces that are even and not slippery. ODEP (2019a) further emphasizes that “facility enhancements such as ramps, accessible restrooms and ergonomic workstations benefit more than just employees with disabilities”. Furthermore, employees who interact with the public or fellow employees in their work can foster an inclusive environment if properly trained to suitably interact with the diversity of all individuals. For those of us with a disability, it is easy to recognize the value of universal design. But with a little imagination, those of us without a disability can also envision how to facilitate an inclusive environment.

Creating and growing an inclusive environment for individuals with disabilities in our work environments requires a number of considerations. First, it requires recognition that disability is a broad notion, and its legal standing has been further broadened by the AADA. Moreover, the courts are still working to determine which individuals are covered by the ADA and AADA. Second, it requires awareness that the legal and technical meaning of “reasonable accommodation” can sometimes be open to interpretation. Third, it requires understanding that even if an individual with a disability is successfully working within our institution’s environment, there is a broader environment outside the work setting that may be less accommodating. For instance, the accessibility of the surrounding community, the structure of the regional transportation network and even local weather may be relevant considerations. Fourth and finally, it necessitates understanding, or at least awareness of one’s own internal reaction to “the other”—a consideration that is applicable to individuals with disabilities, as well as, of course, to other protected classes of individuals. Literature has suggested that fear of one’s own disability can be stimulated by another’s disability and unconsciously trigger avoidance of “the other” (for example, Simon (2014), Livneh (1982)).

### ***Who Is Covered by the ADA?***

Determining whether an individual has a disability can be a challenge. To my knowledge, there is no exhaustive list of disabilities and in some circumstances, whether someone has a disability may require a legal determination. The ADA National Network (2019) notes that “in the context of the ADA, disability is a legal term rather than a medical one” and that the “ADA’s definition of a disability is different from how disability is defined . . . for Social Security Disability related benefits”. Some disabilities are more apparent, for example, using a device for

ambulation, carrying a white cane, using a service animal, or using American Sign Language (ASL). Many other disabilities are less apparent or even “hidden”, for instance, cognitive impairments, psychological disorders, symptomatic cardiac issues, or conditions that ebb and flow.

### ***Reasonable Accommodation***

Providing reasonable accommodations meeting the ADA requirement without “undue hardship” can often be easily accomplished. However, meeting the “undue hardship” requirement can at times become more difficult due to the differing viewpoints of the individual with a disability and the provider of accommodations. These differing viewpoints can arise when either the employer or the individual, or both, have unrealistic expectations. And in other situations, the necessary accommodation may in fact be difficult – but usually not impossible – to implement. Even when a reasonable accommodation may not be considered legally required, it may still be morally or ethically required. In other words, it may simply be just doing the “right thing”.

In the workplace, the ADA specifies reasonable accommodations for individuals with disabilities to ensure (i) equal opportunity in the employment application process, (ii) the performance of the principle job functions, and (iii) full access to benefits and opportunities that are equivalent to all employees.

### ***Reasonable Accommodation (1): Employment Application Process***

Any applicant—whether or not they have a disability—for a job must be able to meet the requirements for the job, for instance, an applicant must have the requisite education, experience, and skills for a job. However, the job application process must allow for reasonable accommodation if and as requested by a potential applicant. The U.S. EEOC has identified a number of examples of possible accommodations. They include alternate forms of written materials, ASL interpreters, or extra time for completing tests, as well as modifying equipment or providing adapted equipment, which may be a component of the interview process. Nonetheless, the employer legally does not have to hire an individual who due to having a disability cannot perform all the essential job functions, but cannot reject an applicant with a disability who cannot perform minor duties not essential to the job. The discussion of a possible reasonable accommodation can occur at varying times during the interview process, but always both applicant and employer should be aware of the legal issues surrounding such an accommodation. Some accommodations are clearly necessary and can be easily handled without “undue hardship” by the

individuals responsible for hiring or supervising. Other accommodations may be more complex and they are best addressed in concert with knowledgeable people in one's organization's human resources or legal departments.

### ***Reasonable Accommodation (2): On the Job***

Once an applicant whom an employer wants to hire requests an accommodation due to a disability, the employer will need to explore with the applicant the specifics of the requested accommodation and how it will allow the applicant to more successfully perform their job duties. More than likely a human resources official will need to become involved in these discussions.

There are a breadth of accommodations that are possible, including, as identified by ODEP, job restructuring, part-time or modified work schedules and acquiring or modifying equipment. For individuals working in the statistical sciences, employers may need to provide, for example, particular accessible software, adapted computer stations, adjustments to environments where lectures or presentation are given (for instance, lowered white boards, adjustable lecterns, and adapted presentation device controls) and corporate and work web materials that meet accessibility for individuals with visual or auditory impairments. In recognition of the impact of the Internet and its particular importance for individuals with disabilities, the Web Accessibility Initiative of the World Wide Web Consortium (W3C) provides guidelines for Internet accessibility. While the focus here is on hiring, all the accommodation notions, of course, are equally applicable to an existing employee who develops a disability while working in the institution or an employee whose disability changes during employment.

It is imperative that one never views providing accommodations as being "special treatment". It is not just the law, it is ethically the right way to act; it is how anyone would want to be treated if the roles were reversed. In those situations where there is an honest disagreement about the scope, cost or feasibility of the accommodation, there is room for negotiation and discussion, it is important to keep discussions professional and nonemotional. An employer benefits from the understanding that for the applicant who has a disability, obtaining a job and being provided an environment where they can excel in their duties may have an additional significance beyond that which it has for an individual without a disability. This additional import may be due to an individual's past experiences with accommodation (or lack thereof) of their disability in other contexts or from the financial reality that less than 40% of individuals with a disability are employed in the US. In developing an accommodation, it can be advantageous for both the employer and the applicant to consult outside resources. These resources may be able to suggest, for example, an accommodation that hasn't yet been considered in the employer-applicant discussions. ODEP has funded the Job Accommodation Network (JAN) to provide technical assistance regarding accommodation in the workplace. This center provides expert and confidential guidance at no cost. The ODEP internet site

on Accommodation provides a list of other resources for potential accommodations. The bottom line is that with good will by both employer and applicant willing to explore innovative approaches, many times a reasonable accommodation without undue hardship can satisfy both.

### ***Reasonable Accommodation (3): All Benefits and Opportunities***

Beyond providing a reasonable accommodation necessary for an employee to do their job, there is the requirement that the employee have available all the benefits and opportunities that all employees have available. Construed most narrowly, this requirement means that at a minimum an employee with a disability must be provided the same health insurance, disability income insurance, institutional training programs and promotion opportunities provided to all other employees. However, there needs to be a broader understanding (ethically, if not legally) of this requirement. There are many activities in professional environments that at their core foster strengthening the teams in which one works. Some activities such as corporate sponsored team-building activities are obvious. Other activities such as off-site group luncheons, after-work receptions and team social functions are not as obvious. At a minimum, these activities should be held in spaces satisfying all ADA requirements and ideally there should be an accessible means to travel to these sites. In my experience, more public facilities than one might expect in the post-ADA world do not comply fully with the law and it can be difficult to tell from a distance how any one space may fall short. Building codes including those addressing remodeling or renovating can vary by municipality. Cities can have inaccessible buildings due to their age and when built that would require undue hardship to comply fully with the ADA or buildings that due to their site are difficult to access. A particular challenge is historical properties due to the increased public emphasis of historic preservation. The National Park Service (1993) in its preservation brief describes ideas to achieve “the highest level of accessibility [that] can be provided while minimizing changes to historic materials and features”.

The ADA National Network Disability Law Handbook created by the Southwest ADA Center, one of ten regional ADA Centers, notes that “Even events like conferences and parties held out of the office should be accessible.” For those of us in the statistical profession, particularly in academics or research institutes, conferences and off-site parties are fairly common. Most major professional conferences held in the U.S. are fully compliant with the ADA. The American Statistical Association with the support of its Committee on Statistics and Disability has for many years had accessible national conferences and encourages its chapter meetings to be held in accessible places.

Parties that are viewed as job-related but held in private homes can be problematic. Very few homes meet any sort of reasonable accessibility standard. When parties like this cannot be changed for particular reasons, some degree of flexibility by an individual with a disability is beneficial.

## ***Accessible External Environment***

While an accessible work environment is most important and one that we as individuals can have the most impact in accomplishing, there are broader accessibility concerns not in our sphere of influence that come into play. Two such concerns are the accessibility of the site where the workplace is located and the transportation/parking situation. Additionally, while inclement weather can affect all individuals, it can cause additional complications to individuals with disabilities. While certain of these issues are largely beyond our control in building an accessible environment for employees, they merit awareness. The environment outside the building where the workplace is located and the interplay of this with transportation can affect access for an employee with a disability. Since most employees are not living within a short walk to work, they arrive by private automobile, public transportation, or ride service. Employees with a disability may also use these. The distance from parking or transport stops can be an important consideration both in terms of distance and accessible pathways from them to the workplace. Employees with limited mobility or visual impairments may also use paratransit services if they are available in the community. Typical paratransit services are ones that provide individuals with accessible transportation that is not available on a system's fixed route services. For individuals with disabilities, paratransit may be particularly used during inclement weather. Depending on the efficiency of the paratransit provided in the community, there can be real delays impacting usual arrival times at work. Employers should be understanding and accommodating when these delays occur.

In some communities, employees may enjoy meeting colleagues or friends for lunch nearby the office. Some may stop and shop before returning home. The surrounding environment's accessibility clearly can impact these activities for employees with disabilities. Supervisors and colleagues should be sensitive to settings where there are environmental access difficulties and be supportive of employees with disabilities. Casual lunches can be arranged at restaurants that are accessible and, if there are none, meals can be ordered and eaten in workplace conference rooms or lounges. Colleagues who run short errands during a work break can offer to pick up items for a colleague with a disability. For long-time colleagues, the offers can be easily made, but for newer colleagues, how these offers are made is important. Particularly important in these social offers of support is to be gracious and avoid sounding patronizing.

## ***Psychodynamic Sources***

There is an increasing amount of literature concerning social and psychodynamic sources of discrimination against individuals who have disabilities. Some of these sources are similar to the sources of discrimination against other minorities. Other sources are thought to be specific to individuals with disabilities. A more complete



discussion of these varied sources would require a lengthy paper and is beyond the scope of this chapter. However, if we want to build and support an inclusive environment in our workplaces for individuals with disabilities, it is useful to have at least a high-level understanding of some of these sources. In advance, I acknowledge my selection of particular issues in this regard reflect to an extent my own perceptions and experiences in response to my disability. There is evidence that persons may perceive an individual with a disability as less capable and, if hired, will likely be less productive. Less commonly occurring is a countervailing perception that has been more recently promoted. As suggested by the ODEP, an individual with a disability who has adapted well can be seen as more capable, resulting in higher expectations imposed on that individual.

To further building a positive inclusive environment, it may be beneficial to consider one's own response to interacting with individuals having disabilities. By better understanding one's own perceptions and possible biases, one can feel more comfortable interacting with individuals with disabilities, thereby being more welcoming and supportive. It has been suggested that some people have a paternalistic attitude toward individuals having disabilities, possibly due to feeling a need to protect individuals one sees as less competent or developed, as one would a child. Another suggestion is that coworkers may experience anxiety or fear about having a similar disability themselves. This latter experience is perhaps unique to disability. Additionally worthwhile noting is that while an employer must not view providing an accommodation as special treatment, this may not stop coworkers from possibly feeling envious of the accommodation provided to another employee in their area. If this envy manifests in the workplace, it obviously must be addressed, but with some delicacy.

For those wishing to read more about the effects of interacting with individuals with disabilities, an early summary is provided by Livneh (1982). A more recent meta-analysis of the effects of sources of discrimination against people with disabilities is given by Ren, Paetzold, and Colella (2008). Both of these articles have led to many citations that provide in-depth access to more of this literature.

## **Behaviors**

Another common reaction occurs when two individuals, one of whom has a clear disability and the other does not, are interacting with a third individual. In this setting, the third individual often will focus their attention and conversation on the individual without the disability and not pay any attention to the individual with a disability. There are innumerable instances where I was with an individual without a visible disability and experienced this lack of focus and yet I was the one responsible for organizing our activity. These occurrences range from business events and social events, such as meals or public performances to simply my asking directions from a passerby or making a purchase. The relative frequency of such reactions has slowly decreased due to the ADA's impact, the general population's growing awareness

of the importance of disability inclusion and the resulting increase in visibility of individuals with disabilities. However, this reaction still happens all too often, and when it does, I instinctively become assertive in the interaction. In fact, when I feel really frustrated and ignored, I will directly ask the person avoiding making contact with me “Are you speaking to me?” While this blunt inquiry may momentarily embarrass the speaker, it does typically achieve the desired effect of re-focusing the interaction. Clearly if you are the one interacting with two others where one has a visible disability, it is important to approach them equally or, if appropriate, address the individual of the two who is initiating the interaction. Similarly if you are, for instance, a guest of an individual who has a disability, and find you are being addressed, refocus the interaction to your host. Hopefully in time, this problematic interaction will become increasingly rarer.

Some interactions seem to be driven by the type of disability an individual has. For example, I learned from an acquaintance who has a severe visual impairment that people seem to naturally speak louder when talking with him. In response, he was likely to reply that there is nothing wrong with his hearing. After we talked about this experience, I realized I was prone to this mistake. Now, when I speak with an individual with a visual disability I consciously monitor the volume of my voice. Similarly, because I don’t know ASL, when communicating with an individual with a profound hearing disability and who lip-reads, I am aware to face the person and attempt to speak clearly and slowly. Depending on the type and severity of hearing disability and when it occurred, an individual with a hearing loss may be able to respond orally. If this is not possible—and like me you didn’t learn ASL—electronic devices would need to be used. Communications at a distance with an individual with a hearing disability can easily be handled by texting over cell phones. With speech recognition technology rapidly improving, there may be other electronic devices to support such communications. Additionally, some individuals have speech difficulties that cause their speaking patterns to differ from what one is used to. These difficulties can be a result of many causes, such as stroke, traumatic brain injury, or cerebral palsy. Being patient and allowing the speaker time to compose their words is important.

When interacting with someone who uses a wheelchair, just view that person like any other person except that the person uses a different mode of locomotion. With the accessibility gains for mobility due to the ADA, users of wheelchairs now experience the environment in much the same way that individuals without a mobility disability experience it. That said, there are some subtle aspects of interaction that merit consideration. In one-to-one conversations lasting more than a few minutes, constantly looking up at a standing individual can be uncomfortable both physically and psychologically for a person using a wheelchair. Moreover, due to the resulting spatial distance, speaking volumes have to be increased beyond those used in typical face-to-face conversations. In such a situation, the individual not using a wheelchair can pull up a chair so that they can chat face-to-face at a normal distance. Some of my more agile friends and colleagues will often just crouch down if no extra chair is readily available. One behavior that I find annoying occurs when I am out with a few other people and we decide to enter a building or place

with an accessible entrance or route that is further away from the nonaccessible route. Surprisingly often somebody will say after recognizing the difference in route lengths that they will meet me at some designated place after we all enter by our different routes. Noting this behavior is not to say that they consciously chose to exclude me. Rather, it is to show how a little common sense, courtesy, and thoughtfulness can go a long way. Pausing, thinking, and acting with intentionality can avoid many of such unnecessary slights, resulting in a more inclusive world.

These noted interactions are intended to be illustrative, but certainly not comprehensive. As discussed, there are many types of disabilities and how they impact specific individuals can vary greatly. Moreover, individuals with disabilities like all people have differing sensibilities. There is clearly no prescriptive approach to interacting with an individual with a disability other than to realize that all humans vary one to another and that everyone wants to be seen as a person of value.

## **Concluding Remarks**

This chapter should be viewed as a window into considerations that can help to make our workplaces and environments spaces where all individuals with disabilities are welcomed, valued, and provided resources that allow them to be fully contributing members of our organizations. Due to my experience with physical, auditory, and visual disabilities, the de facto disabilities emphasized in this chapter are these. It is important to be aware that the ADA includes mental disorders such as autism, major depression disorder, and post-traumatic stress disorder, to mention a few, as well as, for example, pregnancy complications, HIV positive, and dyslexia. Even with all the gains in civil rights over the last few decades for individuals with disabilities, it is highly important to understand that there was a relatively recent time when these civil rights were not readily available. And, moreover, there are still today troubling economic realities and social barriers faced by many individuals having disabilities.

Building and sustaining a workplace that accommodates, supports, and values individuals with disabilities requires awareness of what constitutes a disability both in human and legal terms. Accommodations for an individual with a disability that do not impose an undue hardship often are easily accomplished but they sometimes may require flexibility by the employer. Both the organization and the individual best enter the discussions about accommodation with openness, imagination and, if necessary meaningful compromise. While the external environment related to the workplace is mostly beyond the organization's control, it is beneficial to recognize that the accessibility of this environment can impact employees with disabilities.

As supervisors, colleagues, friends, and acquaintances, there are also personal reactions toward individuals with disabilities that can and do affect our interactions with employees having a disability. Provided in a previous section of this chapter is a short overview of some types of reactions and suggestions of instances how one might temper their behaviors in light of these reactions. It needs, however, to be re-emphasized that understanding the sources and range of these reactions is a still-developing field.

Finally, it would be remiss if we didn't mention that statisticians can play a professional role in improving data collection concerning individuals with disabilities. This is a role that the ASA Committee on Statistics and Disability advances. Our profession has contributed in this regard already, but many more challenges and opportunities remain.

To come full circle, we all should realize that our profession—statistics—is an excellent one for individuals having disabilities. This observation is one that I happily offer from personal experience and also my awareness of the many individuals having disabilities who have successfully and enjoyably worked as statisticians.

## Action Plans

1. Learn the basics of the ADA and its amendment.

The ADA is best viewed as a minimal requirement for accommodation and not a “maximal” requirement for accommodation. There are accommodations that perhaps may not be viewed legally as necessities but would add to the enrichment of the environment at small additional cost. Be cautioned that your legal department may express a concern about this suggested approach for viewing the ADA.

2. Identify your organization's offices and individuals responsible for various aspects of accommodation for and inclusion of individuals with disabilities.

Doing so will allow you to obtain the necessary information if approached by an individual having a disability. If your organization lacks identification of individuals who have the relevant knowledge or responsibilities, encourage your organization to accomplish this.

3. Be attentive to the obvious accommodations your organization has already accomplished.

Are the main entrances to your facility accessible to individuals with mobility impairments? Are there apparent parking spaces that are wheelchair accessible and are they being properly used by cars with appropriate identification? Bathrooms, drinking fountains, and other public facilities should show evidence of awareness of disabilities. Ascertain whether organization web materials are accessible to individuals with visual or auditory disabilities. Make sure in organizational discussions and documents concerning diversity and inclusion that individuals with disabilities are included.

4. Examine your own internal perceptions about people with disabilities.

This can only be considered an action plan item in the very broad sense. Like many of our attitudinal beliefs toward people different from those we were brought up with, these can lead to implicit biases that we are barely aware of. But with honest reflection, we can begin to change these so that we treat all individuals with respect and as employers and coworkers, we support all individuals to achieve their full potential.

**Acknowledgement** The author acknowledges Michael H. Sampson, Esq. for his thoughtful review and very helpful suggestions greatly improving a previous draft of this chapter.

## References

- ADA National Network. (2019). What is the definition of disability under the ADA. Retrieved from <https://adata.org/faq/what-definition-disability-under-ada>.
- CDC. (2017). Disability and health overview. Retrieved from <https://www.cdc.gov/ncbddd/disabilityandhealth/disability.html>.
- Center for Excellence in Universal Design. (2019). What is universal design. Retrieved from <http://universaldesign.ie/What-is-Universal-Design/>.
- DEI. (2019). Disability Equality Index (DEI): 6th annual/2020 benchmark. Retrieved from [https://disabilityin.org/wp-content/uploads/2019/06/Annual\\_DEI\\_Questions.pdf](https://disabilityin.org/wp-content/uploads/2019/06/Annual_DEI_Questions.pdf).
- Kraus, L., Lauer, E., Coleman, R., & Houtenville, A. (2018). *2017 Disability statistics annual report*. Durham, NH: University of New Hampshire.
- Livneh, H. (1982). On the origins of negative attitudes toward people with disabilities. *Rehabilitation Literature*, 43, 338–347.
- National Park Service. (1993). Making historic properties accessible. Retrieved from <https://www.nps.gov/tps/how-to-preserve/briefs/32-accessibility.htm>.
- OCR. (2006). Your Rights Under Section 504 of The Rehabilitation Act. Retrieved from <https://www.hhs.gov/sites/default/files/ocr/civilrights/resources/factsheets/504.pdf>.
- ODEP. (2019a). Accommodations. Retrieved from <https://www.dol.gov/odep/topics/Accommodations.htm>.
- ODEP. (2019b). Building an inclusive workforce: A four-step reference guide to recruiting, hiring, and retaining employees with disabilities. Retrieved from [https://www.dol.gov/odep/pdf/ODEP\\_Flipguide\\_2019\\_508.pdf](https://www.dol.gov/odep/pdf/ODEP_Flipguide_2019_508.pdf).
- Public Law 101-336. (1990). Retrieved from [http://library.clerk.house.gov/reference-files/PPL\\_101\\_336\\_AmericansWithDisabilities.pdf](http://library.clerk.house.gov/reference-files/PPL_101_336_AmericansWithDisabilities.pdf).
- Public Law 110-325. (2009). Retrieved from <https://www.govinfo.gov/content/pkg/PLAW-110publ325/pdf/PLAW-110publ325.pdf>.
- Ren, L. R., Paetzold, R., & Colella, A. (2008). A meta-analysis of experimental studies on the effects of disability on human resource judgments. *Human Resource Management Review*, 18, 191–203.
- Sampson, A.R., Stern, V., Spoeri, R., Kalton, G., Savage, I.R., Sudman, S., Zola, I. (1991). Agenda for access: Scientists and engineers with disabilities. Retrieved from <https://www.stat.pitt.edu/asampson/AgendaForAccessScientistsAndEngineersWithDisabilities.pdf>.
- Simon, S. (2014, May 25). The fear of disability keeps people safe. *Huffington Post*.
- Williams, M. (2018). Facebook 2018 diversity report: Reflecting on our journey. Retrieved from <https://newsroom.fb.com/news/2018/07/diversity-report/>.

# How the Legal System's Failure to Appreciate Statistical Evidence Disadvantages Plaintiffs in Discrimination Cases



Joseph L. Gastwirth

**Abstract** The win rate of plaintiffs in EEO cases is much lower than in other civil cases. This chapter argues that the undervaluing of statistical evidence by courts is a contributing factor. Even when plaintiffs win, the current method of estimating the shortfall in positions they deserve leads to an underestimate of monetary damages and an alternative is proposed.

## Introduction

Studies have shown that the success rate of women who file a claim of employment discrimination is much lower than in other civil cases. Selmi (2001) presented statistics for the period 1995–1997, showing that plaintiffs in employment cases win only about 2% of cases decided on pretrial motions and 30% of trials.<sup>1</sup> In contrast, plaintiffs were successful at trial in over 40% of the cases involving insurance or personal injury. Clermont and Schwab (2009) examined district court decisions between 1979 and 2006 and found that employees' win rate in all phases of employment cases was 15% compared with 51% in other cases.<sup>2</sup> Kotkin (2009) shows that plaintiffs claiming discrimination concerning more than one aspect, e.g., race and sex, have a win rate less than 20% and cites studies showing that plaintiffs in age or disability cases also have very low win rates.

As Sperino and Thomas (2017) emphasize the cumbersome legal procedures, which take a substantial amount of time and effort before a trial on the merits of the case is held, are a substantial impediment. This chapter demonstrates that the underweighting of statistical evidence by courts and their failure to require defendants to

---

<sup>1</sup>Selmi (2001) at 560. Nearly 16% of the employment cases were decided at the pretrial stage.

<sup>2</sup>Clermont and Schwab (2009) at 130.

---

J. L. Gastwirth (✉)

Department of Statistics, George Washington University, Washington, DC, USA

e-mail: [jlgast@gwu.edu](mailto:jlgast@gwu.edu)

show that their criticism of statistical evidence are sufficient to explain a disparity contribute to the low success rate of plaintiffs. The high win rate of employers in all types of fair employment cases diminishes their incentive to diversify their workforce and ensure that all qualified employees have the same opportunity for advancement.

The different criteria and burden shifting procedures used by the courts in equal pay and fair employment cases are described in sections “The Equal Pay Act and the Legal Process Used to Evaluate Claims of Unequal Pay” and “Equal Employment Cases Brought Under Title VII of the Civil Rights Act”. The next section summarizes three important cases, which set out sound guidelines for statistical evidence and describes some types of studies that are consistent with them. Section “Do Lower Courts Often Require More of Plaintiffs Than the Principles Derived from *Bazemore*, *Kempiners*, and *Allen* Indicate?” examines several lower court decisions demonstrating that there is a wide variation in the way courts assess statistical evidence and often require that plaintiffs include more possible characteristics than specified in the relevant major precedential case. Even when plaintiffs prevail, section “When Plaintiffs Prevail in an EEO Case, Do Government Agencies and Courts Award Economic Damages Fairly?” shows that the criteria the Equal Employment Opportunity Commission (EEOC), Office of Federal Contract Compliance (OFCCP) and courts use to award economic damages under-compensates them. An alternative method that will make them “whole” is proposed. Some recommendations to ensure that plaintiffs receive a fair hearing in courts and suggestions for increasing diversity are made in section “Recommendations”.

Before discussing the various types of cases, readers should be aware of some of the preliminary motions that can be filed. At any time, either side can ask for summary judgment, a finding by the judge that the case is clear-cut and there are no genuine issues to any material fact. Defendants have been successful at prevailing at summary judgment, even though the evidence should be viewed in the light most favorable to the party that would lose the case.<sup>3</sup> Indeed, Berger, Finkelstein, and Cheung (2005) found that courts in New York ruled favorably on 64% of defendants’ summary judgment motions in 2000.<sup>4</sup> When expert testimony will be given either side can ask the court to not admit the other party’s expert because it is not scientifically reliable and does not meet the standards set out in *Daubert*.<sup>5</sup> Even when the proposed testimony of plaintiff’s expert survives a *Daubert* review, the defendant can move for summary judgment.<sup>6</sup>

---

<sup>3</sup>*Adickes v. S. H. Kress & Co.* 398 U.S. 144 (1970). In addition, the Court “may not make credibility determinations or weigh the evidence.” *Reeves v. Sanderson Plumbing Products, Inc.*, 530 U.S. 133, 150 (2000).

<sup>4</sup>See Chin (2012–13) for the views of a distinguished appellate judge and Coleman (2012).

<sup>5</sup>*Daubert v. Merrel Dow Pharmaceuticals*, 509U.S. 579 (1993).

<sup>6</sup>Presumably, the expert testimony is focused on an important material fact, so if their reports pass a *Daubert* screen, there is a genuine disagreement about the existence or relevance of that fact.

## The Equal Pay Act and the Legal Process Used to Evaluate Claims of Unequal Pay

The Equal Pay Act (EPA) prohibits employers from discriminating between employees on the basis of sex by paying wages to employees a rate less than the rate at which they pay wages to employees of the opposite sex for equal work on jobs, the performance of which requires equal [skill](#), effort, and [responsibility](#) and which are performed under similar working conditions. The law continues with an exception for wage systems that establish salaries pursuant to (1) a [seniority system](#); (2) a [merit system](#); (3) measures earnings by quantity or quality of production; and (4) a differential based on any other factor other than sex.<sup>7</sup> If an employer has violated the law, it must *raise* the pay of women to that of similarly situated men and *not lower* the pay of any employee.

At the beginning of an EPA case, the plaintiff has the burden of establishing a prima facie case, i.e., she must provide evidence showing that the position she holds has the same level of skill, effort, and responsibility and is performed under similar conditions as the jobs one or more men, with a higher salary, have. A critical issue in determining whether two jobs are equal under the EPA is whether they have a “common core of tasks” or “a significant portion of the two jobs is identical.”<sup>8</sup> The inquiry then turns to whether the differing or additional tasks make the work substantially different.<sup>9</sup> The criteria for “equal work” do not require that the jobs be exactly alike.<sup>10</sup> Once a plaintiff established a prima facie case, the *burden of proof* shifts to the employer who needs to demonstrate that any salary discrepancy arose from one of the four exceptions.

The regulations say that the compared jobs need not be identical but “substantially similar,” which can be interpreted in a variety of ways.<sup>11</sup> Eisenberg (2010)

<sup>7</sup>29 U.S.C. Sec. 206 (d) (1) (2012). And 29 U.S.C. Sec. 213(a)(1)(2006). The original bill was passed in 1963 and extended to white collar workers in 1972 as part of an Education bill (see Eisenberg (2010) at 31 n. 121).

<sup>8</sup>See *Brewster v. Barnes*, 788 F.2d 985, 991 (4th Cir. 1986) and *Stopka v. Alliance of Am. Insurers*, 141 F.3d 681, 685 (7th Cir. 1998) and *Beck-Wilson v. Principi*, 441 F.3d 353,356 (6th Cir. 2006) (focus is on job requirements rather than job title).

<sup>9</sup>See *Brobst v. Columbus Services International*, 761 F.2d 148, 156 (3d Cir. 1985) and *Brennan v. Prince William Hospital Corp.*, 503 F.2d 283 (4th Cir. 1974) at 285–86. Mere comparability of the jobs, however, is not sufficient, as “equal work” requires substantial identity rather than absolute identity, compare *EEOC v. Port Authority*, 758 F.3d 247, 254–55 (2d Cir. 2014) with *Edwards v. Fulton County*, 509 App’x. 882,886 F.3d (11th Cir. 2013).

<sup>10</sup>See *EEOC v. Madison Community United School District*, 818 F.2d 577 (7th Cir. 1987) at 582–83 for a discussion of the difference between substantial identity and identity and cases illustrating how courts have difficulty drawing the distinction.

<sup>11</sup>29 C.F.R. Sec. 1620.13(a) (2009).



summarizes cases that adopted a strict approach when comparing different jobs as well as cases focusing more on the overall function of the jobs at issue.<sup>12</sup>

Justifications of pay differentials based on one of the first three exceptions usually are not very controversial. For example, employers can rely on a seniority system, even if it is *de facto*, provided it is applied in a sex neutral manner.<sup>13</sup> A defendant cannot rely on a seniority system that is not used regularly and applied systematically.<sup>14</sup> The criteria the circuit courts have used to evaluate an employer's use of the fourth (any factor other than gender) exception differ substantially. The second Circuit requires that the gender-neutral factor resulting in a pay disparity is business related.<sup>15</sup> Similarly, in the sixth and ninth circuits the employer must prove that sex is not part of the basis for the wage differential.<sup>16</sup> In contrast, the seventh and eighth circuits do not require that the factor be job-related, only that it does not involve sex and is applied fairly.<sup>17</sup>

Economists and statisticians typically use a multiple regression analysis to estimate the effect of gender after controlling for seniority and productivity factors.<sup>18</sup> Even if a plaintiff submits a regression analysis indicating that females receive statistically significantly lower salaries than similarly qualified males, most courts require the plaintiff to compare herself with at least one "similarly situated"

---

<sup>12</sup>The strict approach was adopted in *Berg v. Norand Corp.* 169 F.3d 1140 (8th Cir. 1999), which held that a female department manager was not equivalent to male department managers, who earned between \$6000 and \$8000 more than the plaintiff. A less stringent criteria was adopted in *Mulhall v. Advance Security Inc.*, 19 F.3d 586, 592-2 (11th Cir. 1994) where two executives had equal responsibility because they both reported directly to the company head and had ultimate responsibility as corporate heads of their divisions.

<sup>13</sup>See *EEOC v. Whitten Mach. Works*, 699 F.2d 688, 689 (4th Cir. 1983) and *Puchakjian v. Township of Winslow*, 804 F. Supp. 2d 288, 297 (D.N.J., 2001, *aff'd* 520 F. App'x 73 (3rd Cir. 2013).

<sup>14</sup>See *EEOC v. Shelby County Gov't*, 707 F. Supp. 969 (W.D. Tenn. 1988) and *Irby v. Bittick*, 44 F.3d 949,954 (11th Cir. 1995). Similarly, *Glover v. KinderCare Learning Centers Inc.*, 980 F.Supp. 437 (M.D. Ala. 1997) said a valid merit system should not be based on ad hoc subjective or personal judgment. Pay differentials based on more productivity have been accepted, e.g., *Bence v. Detroit Health Corp.* 712 F.2d 102 (6th Cir. 1983) or economic benefit, *Byrd v. Ronayne* 61 F.3d. 1026 (1st Cir. 1994) (law firm could pay a male who obtained new clients more than a female who did not).

<sup>15</sup>*Aldrich v. Randolph Cent. Sch. Dist.*, 963F.2d 520, 526 (2nd Cir. 1992).

<sup>16</sup>*Timmer v. Michigan DOC*, 104 F. 3d 833, 844 (6th Cir. 1997). *Kouba v. Allstate Ins. Co.*, 691 F.2d 873, 876 (9th Cir. 1982).

<sup>17</sup>See *Fallon v. Illinois*, 882 F.2d 1206, 1211 (7th Cir. 1989) (describing how the "factor other than sex" defense "embraces an almost limitless number of factors, so long as they do not involve sex"), *Wernsing v. Dep't. Of Human Serv.* 427 F.3d 466, 470 (7th Cir. 2005) and *Taylor v. White*, 321 F.3d 710, 719 (8th Cir. 2003) ("the wisdom or reasonableness of the asserted defense" is irrelevant). Arguments for this interpretation, rather than those of the other circuits are given by *Brown (1995)*.

<sup>18</sup>The use of regression in these cases is discussed by *Ananda and Gilmartin (1991)*, *Gray (1993)*, *Gastwirth and Greenhouse (1995)*, and *Sinclair and Pan (2009)*.

nonminority employee.<sup>19</sup> In addition to a regression analysis showing a significant disparity in pay, the plaintiff in *Lavin-McEleney v. Marist College*, was required to identify a comparator. In that case, the second Circuit accepted a comparison between a female in one department and a male in another department in the same Division of the college.<sup>20</sup> In contrast, in *Strag v. Board of Trustees*, court rejected a comparison of a female Professor in Mathematics to a male in Biology.<sup>21</sup> Because plaintiffs in an EPA case cannot base their arguments primarily on statistical evidence or a comparison of the plaintiff's salary to that of a hypothetical male obtained from a Peters-Belson regression, it is often difficult for them to find an appropriate comparator.<sup>22</sup>

## Equal Employment Cases Brought Under Title VII of the Civil Rights Act

These cases usually concern alleged discrimination in hiring, promotion, or termination and plaintiffs can use one of two theories, disparate impact and disparate treatment. Disparate impact cases concern whether a particular employment practice or requirement, e.g., passing a test or having a high school diploma or college degree, excludes a disproportionate proportion of applicants belonging to a protected group (minority). If a practice has a disparate impact, the employer is required to demonstrate that it is job-related (referred to as "business necessity").<sup>23</sup> There is a large literature describing statistical issues arising in establishing a prima facie case and the requirements for validating a practice with a disparate impact, which is discussed elsewhere.<sup>24</sup>

Because plaintiffs proceeding under the disparate treatment theory need to prove that the defendant intended to discriminate, it is useful to summarize the process

<sup>19</sup>See *Houck v. Va. Polytechnic Inst. & State Univ.* 10 F.3d 204, 206 (4th Cir. 1993) and *Chiaromonte v. The Animal Medical Center* (2d Cir. 2017).

<sup>20</sup>239 F. 3d 476 (2d Cir. 2001).

<sup>21</sup>55 F. 3d 943 (4th Cir. 1995). Statistical evidence was not submitted in the case. See Keohane (1997) for a discussion of this case and problems female professors and coaches' face in EPA cases.

<sup>22</sup>Peters-Belson regression fits an equation predicting male salaries as a function of seniority, education, and other productivity related variables. Then the values of those predictors for each female are used in the equation to predict what her salary would be if she were male. See Gray (1993), Gastwirth and Greenhouse (1995), Graubard (2009), and Sinclair and Pan (2009) for a fuller description and illustrations of its use. Goldberg (2011) at 753–55 illustrates the difficulties plaintiffs in equal treatment cases have in locating sufficiently comparable employees.

<sup>23</sup>*Griggs v. Duke Power*, 401 U.S. 424 (1971).

<sup>24</sup>Statistical procedures for determining disparate impact and for validating a test are described in Biddle (2011), Morris and Dunleavy (2016), and Gastwirth, Miao, and Zheng (2003).

courts use as it differs from the EPA. In *McDonnell-Douglas* and *Burdine*, the Court established a three-step burden-shifting process for disparate treatment cases<sup>25</sup> :

First, the plaintiff must establish a prima facie case.

Then the defendant must articulate, through admissible evidence, a legitimate nondiscriminatory reason for its action.

At the third step, the plaintiff must prove that the defendant's justification is a pretext for discrimination.

The elements of a prima facie case are: (1) the plaintiff is a member of a protected group, (2) the plaintiff applied and was qualified for the job or in a termination case that the plaintiff was performing satisfactorily, (3) the application was rejected, and (4) the position remained open after rejection. The last element can be satisfied if the plaintiff can show that the position was filled by a member of a non-protected group or by showing that other employees received more favorable treatment than those in the protected group.<sup>26</sup> If the plaintiff establishes a prima facie case, the employer has the burden of producing a legitimate explanation, which need not be the true reason for the decisions at issue. Defendant's explanation must be clear and reasonably specific in order to provide the plaintiff with a "full and fair opportunity to demonstrate pretext."<sup>27</sup> Then the plaintiff needs to show that the defendant's justification is a pretext.

This process differs from that used in EPA cases where once the plaintiff establishes a prima facie case of unequal pay for "equal work," the defendant has the *burden of proof* and must provide evidence that the disparity arose from one of the four statutory criteria. In disparate treatment cases, however, the defendant only needs to produce an explanation to rebut plaintiffs' prima facie case and is *not required* to produce evidence supporting it.<sup>28</sup> Indeed, the *burden of proof*

<sup>25</sup>*McDonnell Douglas Corp. v. Green*, 411 U.S. 792 (1973) and *Texas Department of Community Affairs v. Burdine*, 450 U.S. 248 (1981).

<sup>26</sup>*McDonnell Douglas*, 411 U.S.792. at 804. The plaintiff alleged he was not rehired because of his race and the opinion states "Especially relevant to such a showing would be evidence that white employees involved in acts against petitioner of comparable seriousness to the 'stall-in' were nevertheless retained or rehired."

<sup>27</sup>*Lanphear v. Prokop*, 703 F.2d 1311, 1316 (D.C. Cir. 1983) (quoting *Burdine*, 450 U.S. at 256). Recently, in *Figueroa v. Pompeo*, No. 18-5064 (May, 10, 2019), the court listed four criteria the defendant's explanation should meet. The opinion noted that the 11th Circuit would not accept a vague reason, e.g., "we hired the best person" citing *Steger v. Gen. Elec. Co.*, 318 15 F.3d 1066, 1076 (11th Cir. 2003).

<sup>28</sup>The opinion in *Burdine*, 450 U.S. 248 (1981) at 258 notes that "although the defendant does not bear a formal burden of persuasion, the defendant nevertheless retains an incentive to persuade the trier of fact that the employment decision was lawful. Thus, the defendant normally will attempt to prove the factual basis for its explanation." Lower court decisions have emphasized that in Title VII cases employers only need to proffer an explanation and do not need to prove its reason was not gender-based, see *EEOC v. Maryland Ins. Admin*, 879 F.3d at n. 120 (comparing the difference between the burdens of production in Title VII cases to the heavier one of proof in EPA cases). As noted in *Ricser v. QEP Energy*, 776 F. 2d 1191, 1198 (10th Cir. 2015), in EPA cases the employer must submit evidence that does explain the disparity, not simply a reason that could explain the disparity.

*remains on the plaintiff* throughout the litigation. Thus, the strength of the evidence the plaintiff can submit at the “pretext” stage is often the deciding factor as the plaintiff has the burden of showing the defendant’s explanation is not credible. If the plaintiff shows that defendant’s explanation is false or not believable, the trier of fact (jury or judge) may, but need not, find for the plaintiff.<sup>29</sup> The plaintiff has the burden of showing it is more likely than not that the adverse treatment resulted from defendant’s discriminatory intent.

### **Three Important Legal Decisions and the Types of Statistical Studies for Assessing Unfairness That Are Consistent with Them**

The Supreme Court’s discussion of the regression analyses<sup>30</sup> submitted by both parties in *Bazemore v. Friday*<sup>31</sup> describes how courts should assess statistical evidence. The lower courts had rejected plaintiffs’ regression analysis submitted to support their request that a class action be certified for the claim of the plaintiffs, black employees of the North Carolina Agricultural Extension Service, of discrimination in salaries and in the performance evaluation system. The evaluation system placed employees into one of four quartiles. Although the fourth Circuit’s opinion did not believe the data indicated that blacks received lower evaluations, proper statistical analysis shows the disparity was statistically significant.<sup>32</sup> Prior to the Civil Rights Act of 1965, the service paid black employees less than whites, and

---

<sup>29</sup>St. Mary’s Honor Center v. Hicks, 509 U.S. 502, 511 (1993).

<sup>30</sup>There is a large literature concerning the use of statistics and regression in legal cases. See Gastwirth (1988), Fienberg (1989), Zeisel and Kaye (1997), and Finkelstein and Levin (2015). Gray (1993) and Hersch and Bullock (2014) discuss how courts have evaluated data from many cases and suggest that they may under-weight plaintiffs’ regressions by giving too much credence to defendants’ criticism. Greiner (2009) reviews the applicability of causal inference methods in civil rights cases. Sinclair and Pan (2009) and Graubard (2009) discuss the use of Peters-Belson regression, which fits a model to the majority group and compares the actual outcomes (e.g., pay or promotion) of the protected group to its predicted value from the majority equation. Gray (1993) observed that the approach is more consistent with the law than ordinary regression with an indicator variable for gender.

<sup>31</sup>478 U.S. 385 (1986).

<sup>32</sup>See 751 F.2d 662 (4th Cir. 1984) for the data and description of the ranking system and Gastwirth (1988, at 267–68 and 337–38) for appropriate statistical analyses. The opinion, *Id.* at fn. 9, analyzed the data in each county separately and found that Blacks were overrepresented by a statistically significant degree in the fourth (lowest) quartile in only one district. Because the defendant employed about 100 individuals in each district and the minority fraction of employees in some districts was small, the power of a test to reach statistical significance in most districts was low. The proper statistical test combining the disparities in all districts was statistically significant.

a secondary issue was whether pre-Act disparities in pay that continued after the Civil Rights Act was passed violated the new law.<sup>33</sup>

The expert for the United States analyzed salary data for 1974, 1975, and 1981 by regressing pay on race, education, tenure, and job title because an official at the Service stated that salaries were determined from four factors, education, tenure, job title, and job performance.<sup>34</sup> He found that black employees earned \$331 less than whites did in 1974, the disparity was \$395 in 1975 and these were statistically significant at the 0.05 level.

The defendant's regression analysis for 1975 using similar predictors found a significant disparity of \$384, near that of the plaintiffs. After dispensing with some of the minor criticisms of plaintiffs' regression that the lower court had accepted as serious flaws, the opinion *rejected* the lower court's insistence that a regression include *all* potential predictors. The Supreme Court said, "The Court of Appeals erred in stating that petitioners' regression analyses were 'unacceptable as evidence of discrimination,' because they did not include all measurable variables thought to have an effect on salary level." The Court observed that "while the omission of variables from a regression analysis may render the analysis less probative than it otherwise might be, it can hardly be said, absent some other infirmity, that an analysis, which accounts for the major factors "must be considered unacceptable as evidence of discrimination." Normally, failure to include variables will affect the analysis' probativeness, not its admissibility".<sup>35</sup>

In *Riordan v. Kempiners and Randolph*, which reversed a trial judge's directed verdict against the plaintiff after excluding much of her evidence, Judge Posner wrote:

Proof of such discrimination is always difficult. Defendants of even minimal sophistication will neither admit discriminatory animus nor leave a paper trail demonstrating it; and because most employment decisions involve an element of discretion, alternative hypotheses (including that of simple mistake) will always be possible and often plausible. Only the very best workers are completely satisfactory, and they are not likely to be discriminated against—the cost of discrimination is too great.

The opinion then observes that it is difficult for the law to protect the average worker because it is so easy to concoct a plausible reason for not hiring, or firing, or failing to promote, or denying a pay raise to, a worker who is not superlative. Thus, plaintiffs need robust discovery in order to learn how the employer's policies are actually applied.

---

<sup>33</sup>The decision, *Id.* at n.8 noted that if the pre-1965 pay disparities continued, the employer violated the law. For employees hired afterwards, plaintiffs would need to provide evidence that new disparities were created. Prior to 1965, the Service maintained two racially segregated branches and paid black employees less than white employees.

<sup>34</sup>The regression analyses are discussed by the Court on pages 398–399 of the opinion. The opinion does not discuss why the expert did not use the performance rankings in quartiles; however, if they were affected by discrimination, as alleged, including them would mask the effect of race on pay.

<sup>35</sup>Bazemore 479 U.S. 385 (1096) at 399–40.

In *Allen v. Seidman*, 38.9% of black bank examiners passed a promotion exam, in contrast to 84.1% of whites.<sup>36</sup> The defendant suggested that the black candidates might have lesser qualifications. Because all applicants had served the requisite time in the previous position and had at least 5 years of experience, the court thought they were reasonably homogeneous and rejected defendant's criticism. The defendant had not identified a particular job-related characteristic possessed by a noticeably higher fraction of whites than blacks and the opinion noted the defendant could have submitted a regression analysis, including the characteristic that explained the disparity.

These cases indicate that a regression controlling for the major factors, studies based on matched pairs of similarly qualified protected and majority employees or an analysis of the data stratified into similarly qualified subgroups and analyzed by a statistical method summarizing the disparities in the groups into an overall measure and test are appropriate procedures.<sup>37</sup> If a statistically significant difference is found, defendants should do more than suggest a potential additional explanatory factor, they should demonstrate that this additional factor does explain the disparity. Defendants have been successful in submitting a regression analysis that includes more legitimate predictors, which renders any remaining disparity insignificant.<sup>38</sup>

## **Do Lower Courts Often Require More of Plaintiffs Than the Principles Derived from *Bazemore*, *Kempiners*, and *Allen* Indicate?**

### *Statistical Methods Consistent with the Three Cases*

In *Bazemore*, the court noted that the plaintiff's statistical evidence should include the major variables but need not consider all of them. The opinion also noted that an employer can choose between two equally qualified candidates as long as race or gender does not enter into the decision. To study whether race or gender entered into a decision, statistical methods using data stratified by qualification level, minority–majority pairs that are matched with respect to the major factors and the Peters–

<sup>36</sup>Allen, 881 F.2d 375 (7th Cir. 1989). The data and criteria for an omitted variable to explain a disparity in success rates is discussed in Gastwirth (1992).

<sup>37</sup>The Cochran-Mantel-Haenszel statistic and the related Mantel-Haenszel summary odds ratio is commonly used when there are several  $2 \times 2$  tables, e.g., minority and majority pass rates organized by educational level. The procedure was accepted in *Hogan v. Pierce*, 31 FEP Cases, 115 (D.D.C. 1983). Rosenbaum and Rubin (1984) describe a propensity score method for stratifying data into subgroups with similar qualifications.

<sup>38</sup>*Randall v. Rolls Royce Inc.* 637 F.3d 818 (7th Cir. 2011), the plaintiffs analysis showed that female employees in each compensation group were underpaid by 5%. Each group included several different types of jobs and when the defendant's expert included job type in the regression; females were no longer statistically significantly underpaid.

Belson regression method, comparing a minority member's status (salary, hired, or promoted) to their predicted status substituting their covariates into the equation fitted to the data on majority employees or applicants are appropriate.

### *Cases Involving Statistical Evidence*

Kaye (1990) discusses an interesting case alleging sex discrimination in promotion at a University. The plaintiff presented statistics comparing the Dean's treatment of female and male professors being reviewed for tenure with the recommendation to that of the University's tenure and promotion committee. In the spirit of *Kempiners*, he limited the data to those cases where there was disagreement.<sup>39</sup> Of the 21 males the committee and Dean disagreed on, the Dean gave more favorable treatment to 18 and less favorable treatment to only 3. In contrast, of the 11 females where there was a disagreement the Dean gave more favorable treatment to 6 and harsher treatment to 5. Fisher's exact test was applied to the data yielding a  $p$ -value of 0.0877 (two-sided) test and 0.0683 (one-sided).<sup>40</sup> While these results do not quite reach significance at the 0.05 level, in light of the small sample and consequent low power of the test they suggest that the Dean favored males over females. The judge was not persuaded and his opinion says that females might have received a weaker endorsement from the faculty committee than males, i.e., the data should have included the committee's vote. Unlike the *Allen* opinion, the defendant was *not required* to submit data that this was true and would explain the disparity.

The dissenting opinion by Judge Cudahy in *EEOC v. Sears Roebuck* criticized the majority opinion for accepting Sears' argument that women in non-commission sales jobs were not interested in higher paid commission sales positions and noted that even after incorporating information on the job applied for and prior commission sales experience, significant statistical disparities in hiring for most years and in most regions remained.<sup>41</sup> In *Adams v. Ameritech*, however, after noting that layoff rates increased with age, the court did not accept "explanations" that the

---

<sup>39</sup>As noted in *Kempiners*, examining the treatment of the best and poorest employees is not likely to be informative because it is too costly to discriminate against a good employee. Similarly, most employers would not promote poor performers. Thus, if there is bias it will be reflected in the treatment of average or typical employees.

<sup>40</sup>Fisher's exact test is a conditional test, i.e., it incorporates the fact that the Dean gave more favorable treatment to 24 applicants. Because the number of applicants he would be favorable to is not fixed, the Berger and Boos (1994) unconditional test is more appropriate. This test yields  $p$ -values of 0.0683 (two-sided) and 0.0420 (one-sided). If the plaintiff were able to submit other evidence that the Dean disfavored females, then a one-sided test would be appropriate.

<sup>41</sup>*E.E.O.C. v. Sears, Roebuck Co.*, 839 F.2d 302, 361–364 (1988).

defendant considered “potential for growth” or higher education, as they are highly correlated with age.<sup>42</sup>

### *Individual Cases*

In individual cases alleging disparate treatment, it is important to remember that the plaintiff must convince a court that they were not hired or promoted because the employer treated individual of their race or gender unfairly. The success of this claim depends on evaluating the comparative qualifications of the applicants for the position and on analysis of the credibility of the reasons for the provided by those who made the decisions.<sup>43</sup> In practice, even when courts accept that the plaintiff is qualified for the job and allow them to establish a prima facie case, in order for the plaintiff to prevail, courts often ask them to demonstrate that they were *clearly* more qualified than the male comparator, who received the promotion.<sup>44</sup> In order to meet this burden the plaintiff “must present evidence from which a jury could conclude, that ‘no reasonable person, in the exercise of impartial judgment, could have chosen the candidate selected over the plaintiff for the job in question.’”<sup>45</sup> As *Kempiners* observed, it is in differential treatment of *similarly qualified* individuals where the employer loses little by discrimination, i.e., discriminatory practices will manifest themselves when minority and majority individuals are very similar. Thus, the “clearly superior” standard does prevent a plaintiff from using the most informative statistical studies, based on matched pairs or employees stratified into similarly qualified subgroups.

The problem of finding one or more comparators is exacerbated by defining “similarly situated” in a very restrictive manner. For example, courts have required

---

<sup>42</sup>231 F.3d 414 (7th Cir. 2000). The decision reversed summary judgment in favor of the defendant. The defendant had not explained why a higher level of education was needed for the jobs since before the layoff all employees performed satisfactorily.

<sup>43</sup>Gen. Tel. v. Falcon, 457 U.S. 147, 162 (1982).

<sup>44</sup>See *Evans v. Techs. Applications & Serv. Co.* 80 F.3d 954, 960 (4th Cir. 1996) (“Evans simply has failed to demonstrate that she was more qualified than [the comparator for a promotion] and thus more deserving of the duties.”) and *Brown v. Illinois Dep’t. Of Natural Res.*, 499 F.3d 675, 683 (7th Cir. 2007).

<sup>45</sup>*Roberson-King v. State of Louisiana Workforce Commission*, NO. 17–30,899 (5th Cir. 2018), citing *Moss v. BMC Software, Inc.* 610F.3d 917, 922 (5th Cir. 2010) and other cases. In *Millbrook v. IBP, Inc.*, 280 F.3d 1169 (7th Cir. 2002), the court reversed a jury finding of discrimination in a promotion, stating that where an employer’s nondiscriminatory reason for its decision is that it selected the most qualified candidate, evidence of the plaintiff’s competing qualifications does not constitute evidence of pretext “unless those differences are so favorable to the plaintiff that there can be no dispute among reasonable persons of impartial judgment that the plaintiff was clearly better qualified for the position at issue.”



the plaintiff and comparator to be similar in “all material respects.”<sup>46</sup> The recent decision in *Lewis v. City of Union City* described the “all material respects” standard for a comparator as follows.<sup>47</sup> Ordinarily a similarly situated comparator will

1. Have engaged in the same basic conduct (or misconduct) as the plaintiff.<sup>48</sup>
2. Were subject to the same employment policy, guideline, or rule as the plaintiff.<sup>49</sup>
3. Usually will have been under the jurisdiction of the same supervisor.<sup>50</sup>
4. Will share the plaintiff’s employment or disciplinary history.<sup>51</sup>

The opinion noted that minor differences in job function would not disqualify a would-be comparator.<sup>52</sup> Nonetheless, many legal commentators (Lidge, 2002; Goldberg, 2011; Eisenberg, 2012–13; Sullivan, 2009; Altrey, 2018) have argued that the requirements for comparators are overly restrictive.

## When Plaintiffs Prevail in an EEO Case, Do Government Agencies and Courts Award Economic Damages Fairly?

To appreciate this issue, consider the following scenario: A year ago, a large company hired about 200 recent college graduates. All had majored in a job-related field, had similar GPAs, and similar summer internships and jobs. New employees are on probation for 6 months. Most new hires pass this screen. After 1 year, the company promotes 50 of the 100 male and 100 female employees, 40 males and 10 females. The other female employees file an EEO complaint. The EEOC and the court tests the data by comparing the 10 females to the 25 expected, assuming

---

<sup>46</sup>See *Wyninger v. New Venture Gear, Inc.*, 361 F.3d 965, 979 (7th Cir. 2004); *Durkin v. City of Chicago*, 341 F.3d 606, 613–14 (7th Cir. 2003); *Rivera-Aponte v. Restaurant Metropol # 3, Inc.*, 338 F.3d 9, 12 (1st Cir. 2003); *Graham v. Long Island R.R.*, 230 F.3d 34, 39–40 (2nd Cir. 2000). In *Mitchell v. Toledo Hospital*, 964 F. 2d 577, 583 (6th Cir. 1992) the court said the comparator needs to be similar in “all respects.” *Johnson v. District of Columbia*, 947 F. Supp. 2d 123 (D.D.C. 2013) (citing cases requiring comparators to be nearly identical in all relevant aspects).

<sup>47</sup>918 F. 3d 1213 (2019).

<sup>48</sup>*Citing Mitchell v. Toledo Hosp.*, 964 F.2d 577, 580, 583 (6th Cir. 1992) (holding that a plaintiff terminated for misuse of employer’s property cannot comparators who had high absenteeism or were insubordinate).

<sup>49</sup>*Citing Latham v. Dep’t of Children & Youth Servs.*, 172 F.3d 786, 793 (11th Cir. 1999).

<sup>50</sup>*Citing Jones v. Gerwens*, 874 F.2d 1534, 1541 (11th Cir. 1989) (“disciplinary measures undertaken by different supervisors may not be comparable for purposes of Title VII analysis”). However, the 6th Circuit in *Louzon v. Ford Co.* 718 F.3d 556 (2013) downplayed the need for the same supervisor when the other factors were met and if defendant’s definition of supervisor would have limited the plaintiff to just a few potential comparators.

<sup>51</sup>*Citing Tennial v. United Parcel Serv., Inc.*, 840 F.3d 292, 304 (6th Cir. 2016) (differences in experience and disciplinary history can disqualify a plaintiff’s proffered comparator).

<sup>52</sup>*Citing Ercegovich v. Goodyear Tire & Rubber Co.*, 154 F.3d 344, 353 (6th Cir. 1998).

the null hypothesis, employees of both genders have the same pass rate.<sup>53</sup> Fisher's exact test yields a  $p$ -value of  $1.24 \times 10^{-6}$ , much lower than the two to three standard deviation criteria, the Court used in *Castaneda*, and helps to establish a prima facie case.<sup>54</sup> Because the hires of both genders had very similar qualifications and experience, the defendant cannot produce a legitimate explanation and the judge rules in favor of the plaintiffs and needs to calculate economic damages, the monetary equivalent of the positions the plaintiffs lost. The court awards them the value of 15 (25–10) positions.

Is this the correct calculation? This method is called the "shortfall method" and is used by the OFFCP and EEOC.<sup>55</sup> I question whether this method fully compensates plaintiffs because at the end of the process, females would have received the equivalent of 25 positions, while the males received 40, so females received 38.5% of the promotions even though they were 50% of the qualified pool. If the employees who suffered discrimination were to receive the positions instead of money, the female proportion of employees eligible for the next promotion would be 38.5% rather than 50%. Why is the shortfall method *logically flawed*? It is based on an expected value, calculated under the assumption that the promotion rates of males and females were equal. That assumption was shown to be inconsistent with the data previously, when the plaintiffs established their prima facie case. It is illogical to base the damages calculation on an assumption or hypothesis that has been discredited in an earlier phase of the proceedings.

A more reasonable method is similar to Peters-Belson regression, i.e., assume the females should have the same promotion rate as males. Then they would be expected to receive 40 positions, so they should receive damages equivalent to  $40 - 10 = 30$  positions. Thus, the currently used shortfall method only awarded the females who were not promoted 15 or *one-half* of the positions they would have received had they been treated like the male employees.

## Recommendations

Currently, a plaintiff suing a major corporation or government agency for discrimination, under either the EPA or Title VII, has a several important hurdles to overcome before having a trial on the merits before a jury. At the initial stages of a case, alleging discrimination under Title VII, one needs to file a charge with the

<sup>53</sup>The expected number is just the female fraction (1/2) times the number of promotions.

<sup>54</sup>Hypothesis testing was accepted in the jury discrimination case, *Castaneda v. Partida* (1977), where the court used the normal approximation, so two standard deviations corresponds to the usual 0.05 significance level.

<sup>55</sup>See the description of the shortfall method in OFFCP's Directive 310 available at <https://www.dol.gov/ofccp/regs/compliance/directives/dir310.htm> and Section 3c of EEOC's Settlement Standards and Procedures available at [https://www.eeoc.gov/eeoc/litigation/manual/3-4-settlement\\_standards.cfm#section3c1](https://www.eeoc.gov/eeoc/litigation/manual/3-4-settlement_standards.cfm#section3c1)

EEOC before filing a complaint in court. The charge or complaint needs to be clear and comprehensive so the defendant has a chance to respond.<sup>56</sup>

As noted previously, there are two important motions a defendant can make that the plaintiff must respond to: summary judgment or a *Daubert* motion to exclude one or more of her experts. Currently, the defendant can make either or both of these motions *without* diminishing their prospects of ultimately prevailing even if the court rejects their motions. Usually, employers have greater resources than plaintiffs and can use these preliminary procedures to delay the trial until the resources of the plaintiff are exhausted. The following suggestions are intended to make the proceedings fairer and more efficient:

1. Courts should follow the precepts of the cases discussed in section “Three Important Legal Decisions and the Types of Statistical Studies for Assessing Unfairness That Are Consistent with Them”. Furthermore they should refrain from creating their own statistical criteria. For example, when examining data stratified by department or location some courts have said statistical significance should be found in at least one-half of the strata.<sup>57</sup> Notice that if there are 11 strata, under the null hypothesis the number of significant strata follows a binomial distribution with  $n = 11$ ,  $p = 0.05$  and the probability of observing six or more significant results is  $5.8 \times 10^{-6}$  or less than one in a hundred thousand, which is far more extreme than three standard deviations.
2. Congress should limit summary judgment decisions in EEO cases by ensuring that a plaintiff who establishes a prima facie case of disparate treatment or unequal pay receives a full trial. Because the employer’s intent is at issue in disparate treatment cases, the collective wisdom of twelve individuals evaluating whether the employer’s explanation is a pretext is likely to be superior to that of a single judge or even a panel of three appellate judges, from the same socioeconomic strata of society. The current practice of some courts requiring a plaintiff to rebut all of the explanations offered by defendant at the summary judgment stage essentially requires the plaintiff to prove their case twice, once to the judge and again at a full trial.
3. Recent cases have made it more difficult for plaintiffs to prevail in age, disability, and retaliation cases because the Court required them to show that “but for” their protected characteristic they would have received better

---

<sup>56</sup>Because Title VII is remedial, after a preliminary review of the case, the EEOC will act as a mediator and try to help the parties settle the case. If the EEOC cannot assist the parties in reaching a settlement, the plaintiff may request a right to sue letter and file a case in District Court.

<sup>57</sup>See *Apsley v. Boeing*, 722 F. Supp. 1218 (D. Kan. 2010), *aff’d*, 691 F.3d 1184 (10th Cir. 2012) and *Dukes v. Wal-Mart II*, 964 F. Supp. 2d 1115, 1110 (D. Cal. 2013). The appellate decision in *Apsley* did not accept this criterion, although it affirmed the lower court’s granting the employer’s motion for summary judgment. A reanalysis of the data in *Dukes* (Miao & Gastwirth, 2016) showed that the plaintiffs had a much stronger case than was presented.

- treatment.<sup>58</sup> Congress should restore the previous motivating or substantial contributing factor criteria for demonstrating discrimination.
4. In EPA cases, either the Supreme Court or Congress should clarify or rewrite the “any factor other than sex” exception so that it refers only to *job-related* factors. Plaintiffs should also be allowed to use a hypothetical comparator, or at least use a regression analysis to widen the class of potential comparators. For example, if a regression analysis shows that each year of seniority increases one’s salary by \$500, a female earning \$50,000 should be able to compare herself to an employee in the same position whose salary is \$60,000 even if he has worked 3 years longer and argue that she is underpaid by \$8500, the actual difference minus the legitimate seniority differential.<sup>59</sup> Similarly, an employer should be able to show that all or part of the estimated pay differential is explained by job-related characteristics not considered in the hypothetical.<sup>60</sup>
  5. Courts, government agencies, and the relevant professions should try to formulate criteria for a characteristic to be a “major” variable or “relevant” variable. As a start, one might define a variable that the employer actually might use in making the questioned decisions as potentially relevant if information about it is asked of all applicants. Those characteristics that are clearly job-related and actually considered should be regarded as the major variables. Courts should ensure that information about employee’s possessing the major and material factors the employer considered at the time the actions at issue were taken were available at the time. This information need not be computerized, e.g., education and prior experience may be on the original applications. The statistical analyses submitted by plaintiffs should include the major factors or justify why they need not be.<sup>61</sup>
  6. A single or small group of plaintiffs alleging disparate treatment should be able to establish a prima facie case using statistically significant proof of a pattern of discrimination.<sup>62</sup>

<sup>58</sup>See *Gross v. FBL Financial Services*, 557 U.S. 167 (2009) (age discrimination) and *Univ. of Texas Southwestern Med. Ctr. v. Nassar*, 133 S. Ct. 2517 (2013) (retaliation).

<sup>59</sup>Reversing summary judgment in *Boumehti v. Plastags Holdings Inc.*, 489 F. 3d 781 (2d. 2007), the court noted that the one-year difference in seniority was not sufficient to explain the \$2.00/h disparity as the typical annual raise was no more than \$1.00/h.

<sup>60</sup>For example, in an EPA case in a University setting, a Peters-Belson regression might yield an estimated salary disparity of \$10,000. Due to the number of subfields with a discipline, it is not possible to incorporate that information in a regression. The University should be allowed to submit evidence that the subfield the plaintiff works in typically earns less, say \$5000, than the average in that discipline, which would reduce the plaintiffs’ expected pay by that amount.

<sup>61</sup>Because the *Burdine* decision states that employers are not required to provide the actual reason, it is important to make sure that evidence relevant to deciding whether the offered justification is a pretext is preserved and available. Clarifying the important job-related characteristics relatively early in the proceedings enables both sides to focus their evidence on the effect membership in the protected group had on the employment decisions under review.

<sup>62</sup>See D. J. Bross (2004) advocating that such evidence should shift the burden of persuasion but noting, at 804, that most Circuit courts do not allow this. Recommendation 6 allows courts

7. Courts should allow plaintiffs in class actions to satisfy the “commonality requirement” with statistics demonstrating that they receive poorer treatment in a large majority of department or locations rather than requiring that the employer discriminates against *all* class members in the same way.<sup>63</sup>
8. If a party (defendant or plaintiff) moves for summary judgment, which is denied, at the trial the jury should be informed that the plaintiff’s or defendant’s arguments were reviewed by the judge and found to be plausible, i.e., this is not a frivolous case but a serious one.
9. If the proposed testimony of an expert, either plaintiff’s or defendant’s, is subject to a *Daubert* hearing raised by the opposing party and the court decides that it is sufficiently reliable to be admissible, the jury should be informed that the scientific basis of the testimony has passed a review of its reliability. The jury should be told that while it need not accept the expert’s testimony, it is not “junk science” but is based on reasonable methodology and should be carefully considered.
10. Statistical societies should provide training, at low cost, to lawyers, especially those taking on plaintiffs cases, to reduce the number of cases that are dismissed because incomplete data or data without analysis is presented.

While these recommendations should assist the legal process to be fairer to those harmed by discrimination, thereby encouraging employers to give more opportunities to minorities, it is more important that minorities receive better education and training when they are young. For example, preschool should be available to all children, so minority children have the same background knowledge as others when they begin elementary school. Ultimately, in order to increase diversity in the work force, one needs to diversify the pool of individuals who are qualified to perform jobs in the new economy, many of which will require specialized education and skills.

---

to preserve the burden shifting protocol while giving plaintiffs a fair chance to survive summary judgment and receive a full trial.

<sup>63</sup>See *Ross v. Lockheed Martin Corp*, 267 F. Supp. 3d 174 (D.D.C. 2017) (citing “*Wal-Mart v. Dukes*, 564 U.S. 338 (2011) which said Rule 23(a) Commonality requires that the employer has discriminated against all class members in the same way). Courts have long realized that when examining data over a reasonable time, there may well be a small period where a fair employer under-hires a minority group, see *Roman v. ESB Inc.* 550 F. 2D 1343, (4th Cir. 1978). In *Pouncy v. Prudential Insurance Co.*, 499 F. Supp. 427, 438 (S.D.Tex. 1980), *aff’d*, 668 F.2d 795 (5th Cir. 1982), the court stated that the plaintiff must prove more than the mere occurrence of isolated “accidental” or sporadic discriminatory acts. Similarly, an unfair employer will have a few locations or time periods where there was no disparity but a significant disparity may exist in most locations or when the assumptions for combining the results in each locations into a single summary analysis of all. Statistical methods exist to test for a common pattern in subgroups, see Gastwirth, Miao, and Pan (2017) for an illustrative example.

## References

- Altrey, S. (2018). Comparison in intersectional discrimination. *Legal Studies*, 38, 379–395.
- Ananda, S., & Gilmartin, K. (1991). Inclusion of potentially tainted variables in regression analyses for employment discrimination cases. *Berkeley Journal of Employee and Labor Law*, 13, 121–152.
- Berger, R. L., & Boos, D. D. (1994). P-values maximized over a confidence set for the nuisance parameter. *Journal of the American Statistical Association*, 79, 1012–1016.
- Berger, V., Finkelstein, M. O., & Cheung, K. (2005). Summary judgment benchmarks for settling employment discrimination lawsuits. *Hofstra Labor and Employment Law Journal*, 23, 45–67.
- Biddle, D. A. (2011). *Adverse impact and test validation: A practitioner's handbook* (3rd ed.). Scottsdale, AZ: Infinity.
- Bross, D. J. (2004). The use of pattern-and-practice by individuals in non-class claims. *Nova L. Review*, 3, 795–815.
- Brown, J. K. (1995). Crossing the line: The second, sixth, ninth and eleventh circuits misapplication of the equal pay acts “any other factor than sex” defense. *Hofstra Labor Law Journal*, 13, 181–208.
- Chin, D. (2012–2013). Summary judgment in employment discrimination cases: A judge's perspective. *New York Law School Law Review*, 57, 671–682.
- Clermont, K. M., & Schwab, S. J. (2009). Employment discrimination plaintiffs in Federal Court: From bad to worse. *Harvard Law and Policy Review*, 3, 103–132.
- Coleman, B. D. (2012). Summary judgment: What we think we know versus what we ought to know. *Loyola University of Chicago Law Journal*, 43, 705–725.
- Eisenberg, D. T. (2010). Shattering the equal pay Act's glass ceiling. *SMU Law Review*, 63, 17–72.
- Eisenberg, D. T. (2012–2013). Stopped at the starting gate: The overuse of summary judgment in equal pay cases. *New York Law School Law Review*, 57, 815–839.
- Fienberg, S. E. (Ed.). (1989). *The evolving role of statistical assessments as evidence in the courts*. New York: Springer.
- Finkelstein, M. O., & Levin, B. (2015). *Statistics for Lawyers*. New York: Springer 3rd ed.
- Gastwirth, J. L. (1988). *Statistical reasoning in law and public policy*. Orlando, FL: Academic Press.
- Gastwirth, J. L. (1992). Methods for assessing the sensitivity of statistical comparisons used in title VII cases to omitted variables. *Jurimetrics Journal*, 33, 19–33.
- Gastwirth, J. L., & Greenhouse, S. W. (1995). Biostatistical concepts and methods in the legal setting. *Statistics in Medicine*, 14, 1641–1653.
- Gastwirth, J. L., Miao, W., & Pan, Q. (2017). Statistical issues in *Kerner v. Denver*: A class action disparate impact case. *Law, Probability and Risk*, 16, 35–53.
- Gastwirth, J. L., Miao, M., & Zheng, G. (2003). Statistical issues arising in disparate impact cases and the use of the expectancy curve in assessing the validity of pre-employment tests. *International Statistical Review*, 71, 565–580.
- Goldberg, S. B. (2011). Discrimination by comparison. *The Yale Law Journal*, 120, 728–812.
- Graubard, B. I. (2009). Comment on “using the Peters-Belson method in equal employment opportunity personnel evaluations” by Sinclair and Pan. *Law Probability and Risk*, 8, 119–122.
- Gray, M. W. (1993). Can statistics tell us what we do not want to hear? The case of complex salary structures. *Statistical Science*, 8, 144–158.
- Greiner, D. J. (2009). Causal inference in civil rights litigation. *Harvard Law Review*, 122, 533–598.
- Hersch, J., & Bullock, B. D. (2014). The use and misuse of econometric evidence in employment discrimination cases. *Washington and Lee Law Review*, 71, 2365–2429.
- Kaye, D. H. (1990). Improving legal statistics. *Law & Society Review*, 24, 1255–1276.
- Keohane, L. W. (1997). Universities, colleges and the equal pay act: The fourth circuit analyzes a salary dispute in *stag v. Board of Trustees*. *Campbell Law Review*, 19, 333–348.

- Kotkin, M. J. (2009). Diversity and discrimination: A look at complex bias. *William and Mary Law Review*, *50*, 1439–1500.
- Lidge III, E. F. (2002). The courts' misuse of the similarly situated concept in employment discrimination law. *Missouri Law Review*, *67*, 831–882. at 835.
- Miao, W., & Gastwirth, J. L. (2016). Statistical issues arising in class action cases: A reanalysis of the statistical evidence in *Dukes v. Wal-Mart II*. *Law, Probability and Risk*, *15*, 155–174.
- Morris, S. B., & Dunleavy, E. M. (2016). *Adverse impact analysis: Understanding data, statistics and risk*. New York, NY: Routledge.
- Rosenbaum, P. R., & Rubin, D. B. (1984). Reducing Bias in observational studies using sub-classification on the propensity score. *Journal of the American Statistical Association*, *79*, 516–526.
- Selmi, M. (2001). Why are employment discrimination cases so hard to win? *Louisiana Law Review*, 555–575.
- Sinclair, M. D., & Pan, Q. (2009). Using the Peters-Belson method in equal employment opportunity personnel evaluations. *Law Probability and Risk*, *8*, 95–117.
- Sperino, S. F., & Thomas, S. A. (2017). *Unequal: How America's courts undermine discrimination law*. Oxford: Oxford University Press.
- Sullivan, C. A. (2009). The Phoenix from the ash: Proving discrimination by comparators. *Alabama Law Review*, *60*, 191–239.
- Zeisel, H., & Kaye, D. H. (1997). *Prove it with figures: Empirical methods in litigation*. New York: Springer-Verlag.

**Part VII**  
**Data Telling and Storytelling**



# Data, Imagination, and Action in the Profession of Statistics: Working with the Annual and CBMS Surveys



Thomas H. Barr

**Abstract** The Mathematical and Statistical Sciences Annual Survey and the CBMS Survey of Undergraduate Mathematics Programs are resources of key value to the statistics community. Their use in specific cases illustrates their scope, potential utility for leaders in the profession of statistics, and opportunities for future innovation.

The Mathematical and Statistical Sciences Annual Survey and the Conference Board of the Mathematical Sciences Survey of Undergraduate Mathematics Programs are key, ongoing projects that track the professional arena of mathematicians and statisticians in academia in the US. Along with other resources that cover STEM, these surveys provide a reliable, comprehensive way to answer questions regarding diversity, inclusion, and the network of those who participate in the teaching, research, and succession connected with these disciplines. In this chapter, we illustrate these claims with a few brief case sketches, provide outlines and highlights of the surveys, and point out some of their shortcomings and the implicit opportunities. In conclusion, we suggest ways in which leaders in the statistical and mathematical communities can use these rich data sources to help them fulfill their roles in shaping the future of the profession.

## Queries and Answers

As part of my work at the American Mathematical Society (AMS), I am often presented with questions having to do with “data.” They come from department chairs, graduate directors, faculty, AMS committees, AMS staff, other professional organizations (such as the American Statistical Association), and journalists. These

---

T. H. Barr (✉)  
American Mathematical Society, Providence, RI, USA  
e-mail: [thb@ams.org](mailto:thb@ams.org)

questions touch on such topics as PhD production in statistics and mathematics, the gender balance of tenured faculty in R1 departments, the numbers of African Americans earning degrees, teaching loads, stipends for graduate teaching assistants, and comparative faculty salary levels in peer departments. My colleagues and I who run the *Mathematical and Statistical Sciences Annual Survey* (Annual Survey, or just Survey here), often field these questions, and at times pass them back and forth. I may be able to give a quick answer by pointing to a page or table in one of our reports, or it may take time, effort, and consultations to infer an answer from data we collect and from our reports. In other instances, we have to exercise a good bit of imagination to devise a way to use existing data sources to approximate a response. At still other times, we may have to respond that we don't track the information the questioner is seeking, or we can't provide it because of confidentiality concerns. In these instances, perhaps we can give the questioner a pointer to possible sources.

Often, I am able to point a questioner to information in the Conference Board of the Mathematical Sciences (CBMS) Survey (2019), a detailed, every-5-years look at undergraduate math and stats programs in both 2-year and 4-year institutions. The members of CBMS are a diverse group of 17 professional organizations (listed in the Appendix) concerned with the teaching, learning, participation, professionalism, research, practice, and public awareness regarding statistics and mathematics. This survey deserves to be better known, and as of this writing, with support from NSF, it is ramping up for its *tenth* iteration in the 2020 CBMS Survey. Thus, there is more than passing attention to this project in these pages.

In our regular work of gathering data and preparing reports, as well as in responding to ad hoc requests, we operate in the hope that the mathematics and statistics community finds the deliverables not only interesting but also actionable, that is, the information is put into the service of making good decisions that affect the people who teach, conduct research in, and practice statistics and mathematics. It is sometimes easy to forget that these activities are carried out by groups of individuals, and that mathematical and statistical knowledge is a product of human brains. Math and stats are phenomena emerging out of social, and ultimately biological, processes. Even though quantitative sciences have an otherworldly air about them in the collective mind, these are deeply humanistic activities.

The goal of this chapter is to:

- Provide anecdotal illustrations of questions that arise in and about the mathematics and statistics community.
- Show how two major, ongoing surveys of the community can be used to answer some of those questions.
- Show how imagination and work can supplement what these surveys provide.
- Point out their scope and limitations.

## Talking Points for an International Crowd

Recently, I received a request from a volunteer, titled leader in the mathematics community for a collection of talking points in preparation for this individual's participation in a panel at an international meeting on the training and professional status of mathematicians who work in the business/industry/government (BIG) sector in the US. The request contained another dimension that I had not previously contemplated in a practical way. What points would be relevant and interesting to a mathematical audience not just from North America but with substantial representation from Europe, Asia, Africa, South America, and Australia?

The Annual Survey reports do contain lots of information about academic statistics and mathematics departments and a little bit about career directions of new PhDs, but it is not spelled out in a way that allows simply plucking items from the reports and assembling them. I stared at this collection of "trees" looking for the proverbial "forest." Ultimately, I settled on an overview of the Annual Survey organized around the four major reports—New Doctorates, Recruitment-Hiring-Attrition, Academic Salaries, and Department Profile—and identified highlights from recent years' reports that seemed to have relevance to the BIG questions. With several hours' effort, I assembled an email containing a few paragraphs on each report as well as a sampling of profiles of industry mathematicians who had recently appeared in the *Notices*.

## Part-Time Instructors, TA Training, and TA Pay

A couple of years ago, a bundle of questions about mathematics and statistics teaching staff came my way. They had to do with numbers of part-time mathematics and statistics instructors in 4-year institutions, how much of the overall teaching load they carry, how much training part-timers get, whether they are provided office space, and how much they are paid per course. A joint committee of professional organizations wanted this information, and the questions came to me because my predecessor had agreed to take on this project.

A few bits of information in the Annual Survey answered some of these questions. For instance, the Survey collects overall numbers of part-time faculty—in the fall of 2016, there were approximately 7900 part-time math faculty nationwide, and almost 300 in the PhD-granting statistics and biostatistics programs (the Survey does not currently track part-time faculty who teach stats or biostats in master's-level or bachelor's level statistics departments). The Survey follows average undergraduate and graduate teaching loads per full-time faculty broken down by the groupings, but it doesn't tie any loads to part-time people.

However, the CBMS Survey does look at such numbers: the 2015 Survey found that in all levels of statistics departments combined, about 14% of introductory statistics sections were taught by tenured or tenure-eligible faculty, 25% were

taught by other full-time faculty, 10% were taught by part-time faculty, and 31% were taught by graduate teaching assistants. Neither the Annual nor CBMS Survey reports on training, office space, or part-time faculty pay.

I examined other data sources, reports, and publications: for instance, from the National Centers for Educational Statistics (NCES/IPEDS), the American Association of University Professors (AAUP), the Council of Graduate Schools (CGS), the Chronicle of Higher Education, the AMS's Find-a-Graduate Program web site, and a range of online reports sponsored by other professional organizations regarding instructor training. Without going into details, suffice it to say that a picture began to emerge that allowed fuller answers to the questions. The activity turned into a full-blown research project, and there was plenty of information in my report to give them qualified answers and leads for their own explorations. My hope was that, while I did some "fishing" for this committee, I was at least as successful at showing them "how to fish."

What do mathematics and statistics graduate teaching assistants get paid? What are their assigned duties? These questions came independently of the earlier bundle from a chairperson wanting a better understanding of the national picture. His purpose was to enter fully prepared into discussions at his institution on the question of TA stipends.

The first stop was the Find A Graduate Program (American Mathematical Society, 2020) resource on the AMS web site, which lists key characteristics of hundreds of graduate programs in mathematics and statistics across the country in a way that allows comparison shopping for undergraduates who are applying to graduate programs. Among the items that departments can include in their postings are average minimum and average maximum TA stipends. Additionally, the US Department of Education's National Center for Educational Statistics contained a report—albeit from 2011–2012, a few years old—profiling graduate student financial aid across the country (National Center for Educational Statistics, 2011). My report to this chairperson wrapped up more neatly than that for the committee.

## **A Reporter Calls**

A reporter from a major newspaper recently reached out for help with finding and interpreting information in the Annual Survey. The goal was to corroborate figures from other sources about the numbers of African Americans earning PhDs in mathematics and serving in tenured faculty positions. The Survey does track PhDs earned by race, ethnicity, and gender, so it was straightforward to discuss with the reporter the meaning of figures in our reports. Putting these numbers together from recent years' reports was not hard, though it was not especially comfortable to acknowledge the longstanding disparity that these figures demonstrated. For some years, leading up to the present, no more than about 1% of the cohorts of new PhDs in mathematical and statistical sciences are African American.

## Diversity and Inclusion Study

In late 2017, the AMS agreed to participate in the NSF-funded STEM Inclusion Study (Cech & Waidzunas, 2011), a multiyear study of science, technology, engineering, and mathematics investigating “the experiences of professionals from across STEM disciplines and industries to identify potential mechanisms of disadvantage at the interpersonal, organizational, and professional levels.” Its objectives include shedding light on “the contours of inequality by gender, race/ethnicity, and disability,” and it is the first study of its kind regarding inclusivity. It is also the first study to systematically examine the experiences of lesbian, gay, bisexual, transgender, and queer (LGBTQ+) professionals in STEM.

A number of professional organizations were asked to participate, but the investigators left it to those opting in to decide how much about their participation to disclose. AMS decided to share with its stakeholders and the wider community the preliminary findings based on responses from a large sample of the Society’s membership. Those findings are discussed in an AMS blog post (Grundman, 2018). Responses indicated that AMS members generally have positive experiences in their workplaces—for instance, across demographic groups, individuals feel their work is respected by colleagues and administrators, and few reported incidents of harassment or high levels of LGBTQ bias. At the same time, “. . . women and respondents with disabilities report significantly less-positive experiences than men and respondents without disabilities ‘on nearly every measure of marginalization and professional devaluation’ examined in the study, and that there is ‘a pattern of negative experiences’ for LGBTQ individuals.”

By chance, the opportunity to participate in the STEM Inclusion Study coincided with yet another query to our office, this one from an AMS committee seeking to ascertain how the experiences of women mathematicians are shaped by the climates and environments in the departments where they study and work. We had no data on this question, and yet it seemed pressing enough to consider devising a modest study to obtain preliminary insights. A broadly based study, conducted by social scientists, was well beyond the capacity of the current AMS staff to conduct, so the STEM Inclusion Study turned out to be a windfall, especially for this committee.

While the Inclusion Study’s findings might not be universally acclaimed as “good news” in the mathematical community, they prompt thought and action based on a reasonable picture of the experiences of individuals in groups that have historically been underrepresented in the mathematical and statistical professional arena. Such surveys of individuals (as opposed to departments) have the potential to transform how we think about research, teaching, and practice of mathematical and statistical sciences and bring more clearly into focus the fact that these are human activities taking place in the company of others doing the same things.

## A Business Model of the Mathematical and Statistical Professionals

For a general discussion of the whole of postsecondary teaching, research, and practice in mathematics and statistics, it might be helpful for a moment to regard this “system” as an enterprise with the twofold objective of:

- Research—creating new and useful knowledge.
- Teaching—cultivating statistical and mathematical awareness, competency, and efficacy among people in the general college population.

Customers for the *research* work are such entities as:

- Academic institutions (they buy the prestige of researchers, may profit from the intellectual property generated, and purchase on behalf of the larger community).
- Foundations (they purchase new knowledge from researchers on behalf of the general population in the belief that specific purposes will emerge).
- Companies (they purchase IP and expertise for their own advancement).

The principal customers for *teaching* are academic institutions. They buy the teaching services from the “system” of professional mathematicians and statisticians, and they resell these services in order to meet the demand the institutions have from their customers—college students and their parents—for training and certification in these disciplines.

Finally, most businesses have a succession plan, a way to handle the eventual attrition of their current leaders and employees so as to sustain the enterprise. In the sphere of academic mathematics and statistics, PhD training can be regarded as the succession plan—a subset of those who complete doctorates will become the principals of the academic enterprise in the future.

Data sources such as the surveys discussed here inform “quality control” in this enterprise. Tracking salaries, for instance, gives a sense of the balance between supply and demand, and it can guide the thinking and action of leaders in the fields, professional organizations, or institutions. Following institutions’ faculty recruitment provides the basis for attempting to steer production in one direction or another, even as market forces are an inevitable part of the picture. Measures of the diversity of the work force hint at quality. It is reasonable to believe that talent and motivation for mathematics and statistics occur at roughly the same rate across racial and ethnic groups. Between 12% and 14% of the US population is African American, and yet the Annual Survey shows, as noted in an anecdote above, that fewer than 1% of PhDs in mathematics and statistics are awarded to African Americans.

Leaders should—and do—notice such disparities, and they might see in them lost opportunity for the wider community. In the future, with attention to conditions along the training pipeline, many more might follow the professional pathway of mathematician or statistician. The numbers present a call to action, and they also give a way of telling whether those actions make any difference.

## Two Sources of Information on the Mathematical and Statistical Sciences

The stories above not only illustrate the use of various sources of information about the statistical and mathematical professional arena in the milieu of higher education, they suggest the “business” model for this arena may provide a useful perspective on the human dimensions of this enterprise. The wider communities that these professionals serve through teaching and research constitute a “market,” and PhD training is “succession planning” for the profession. Here, we focus on the two principal sources already illustrated and give a few hints at what they provide and how they might be used.

1. *The Mathematical and Statistical Sciences Annual Survey*, referred to already as the *Annual Survey*. This every-year census of departments in 4-year universities and colleges in the US is sponsored by the AMS, the American Statistical Association (ASA), the Mathematical Association of America (MAA), the Institute for Mathematical Statistics (IMS), and the Society for Industrial and Applied Mathematics (SIAM). It is conducted by the AMS staff, and its reports are published in the *Notices of the AMS*. Its work is guided by a joint committee consisting of membership from these organizations; the chair of this committee serves as an author on the reports.
2. *The Conference Board of the Mathematical Sciences (CBMS) Survey*. This every-5-year sampling survey focuses on undergraduate education in the US—characteristics of teaching faculty (education, gender, race, and ethnicity), pedagogy, curriculum, administrative structure, and much else. The reports on the CBMS Survey give deep insight to the professional and learning environments for mathematics and statistics. The Survey also has the unique role of looking at the programs, curricula, and people involved in teaching mathematics and statistics in the nation’s community colleges. Less well-known but more detailed than the Annual Survey, this survey and its reports have been ongoing since 1970.

## The Annual Survey

### *Early Days*

In 1957, the AMS commenced an academic salary survey of mathematics departments in the United States. Not coincidentally, later that same year, the USSR pulled ahead of the US in the space race with Sputnik’s successful earth orbit. The nation’s reliance on science, technology, engineering, and mathematics for innovation and production had continued to ramp up after the end of WWII, a reason to create incentives to take up STEM work. In particular, there was a rationale for tracking the compensation of people who worked in this arena, and the

mathematics community did just that. From the original survey came the “Report of the Committee to Investigate the Present Economic Status of Teachers,” (Givens, 1957) and in it the authors emphasized that the survey was not comprehensive (it was sent to 42 of the “best” programs in the country), but that it attempted to gauge the salaries of mathematicians who were training the next generation of professional mathematicians. At the heart of the original salary survey was succession planning!

Part of the questionnaire sent to the sampling of departments was, “Do you think you pay extra for certain fields? What fields? How much?” Among the responses to this question, the field of statistics was mentioned more frequently than any other, and the dollar figures and percentages mentioned suggest that statisticians commanded a premium of roughly 20% over their mathematical colleagues. Interestingly, a back-of-the-envelope calculation of the means of Doctoral Math salaries and Stats/Biostats salaries from the graph on the first page of the “2017 – 2018 Faculty Salaries Report” (Golbeck, Barr, & Rose, 2018b) shows that essentially the same salary premium persists today.

After this first report, the AMS Council enlarged the committee from its initial three members to seven, and the new members included David H. Blackwell, a contributor to game theory, probability theory, information theory, and Bayesian statistics—and also the first African American tenured professor of statistics at UC Berkeley.

## *Present Day*

The simple salary survey has grown over the years, and today the Annual Survey incorporates four components that together attempt to gauge the status—economic and otherwise—of the academic profession based in mathematical and statistical sciences:

- Salary Survey.
- Departmental Profile.
- Recruitment, Hiring, and Attrition.
- New Doctorates Survey and the Employment Experiences of New Doctorates.

Under each of these headings, the AMS conducts a census of some 1514 departments of mathematical and statistical sciences that broadly break down along the following lines:

- PhD-granting departments:
  - Mathematics departments (Large Public [26], Medium Public [40], Small Public [73], Large Private [24], and Small Private [28], classified according to the PhD production rate).
  - Applied Mathematics departments [30].
  - Statistics departments [61].
  - Biostatistics departments [46].



- Master's-granting departments (includes mathematics, statistics, etc.) [178].
- Bachelor's-granting departments (includes mathematics and statistics) [1008].

These counts are updated regularly, and they are current as of 2019. Five reports per year (New Doctorates and Employment Experiences are now two reports, but published side by side) are published in the *Notices of the AMS*. Along with the tables on which these reports are based, the reports also reside on the AMS's Data on the Profession section of its web site. Some of the findings of recent reports are described here.

### ***New Doctorates and Employment Experiences Reports***

Graduate programs in the US currently produce between 1900 and 2000 PhDs in the mathematical sciences (departments of mathematics, applied math, statistics, and biostatistics) each year. About a quarter of these PhDs are in statistics and biostatistics. From 2007 to 2016, that number has increased by an average of about 4% annually. The fraction of these PhDs who are US citizens has climbed a bit from 43% in 2007 and plateaued at just less than 50%. Over this same period, the percentage of PhDs who are women has edged downward from 31% in 2007 to about 28% for the 6 years ending in 2016. In 2016, about 8% of the US citizen PhDs were underrepresented minorities. In the years 2007, 2008, and 2009, unemployment among new doctorates rose from about 1% to 5%, and in the successive years, unemployment among these individuals immediately after completing the degree has run between 4% and 7%.

In the 5 years 2012 to 2016, the percentage of new doctorates going into academic jobs in the US has followed a slight downward trend from 60% to 54%, and a similar though less dramatic decline has occurred in the fraction who take academic jobs outside the US—12% down to 10%. Proportionally more of the new PhDs have taken jobs in business, industry, and government, the percentage increasing from 27% in 2012 to 34% in 2016. The percentage of PhDs taking industry jobs outside the US has hovered between 1% and 2% over this period. See (Golbeck, Barr, & Rose, 2019a, b) for the most current figures.

### ***Recruitment, Hiring, and Attrition Report***

In 2016–17, there were about 2000 academic positions in mathematical and statistical sciences recruited and about 1700 filled. About 45% of the positions filled were tenure track, and about 30% (232) of the tenure-track hires were new PhDs. Of the non-tenure-track hires (1023), approximately 61% (663) were new PhDs. Thus, about 895 new PhDs got academic jobs in this cycle. See (Golbeck, Barr, & Rose, 2018a) for more details.

### ***Academic Salaries Report***

This report gives distributions of reported faculty salaries in the bachelor's, master's, statistics, biostatistics, and six mathematics PhD-granting department groups. The numbers are indicative of salaries overall, but there is no adjustment in the report to account for, e.g., biases among nonrespondents. See (Golbeck, Barr, & Rose, 2018b) for details, and for the definitions of the department groups. In recent years, ASA has conducted a salary survey among statisticians. Those results appear in *AMSTATNews* each year, and the most recent of these reports is (Ange, George, LaLonde, & Wasserstein, 2019). The results of this data gathering are incorporated into the Annual Survey's salary reports.

### ***Department Profile Report***

This report provides a broad picture of mathematical and statistical sciences departments around the country: faculty demographics, undergraduate enrollments and major counts, graduate enrollments, degree counts, and more. Across the US in 4-year colleges and universities, there are between 25,000 and 26,000 full-time mathematical and statistical sciences faculty distributed across the 1500 departments in 4-year institutions; roughly 5300 of these faculty are in statistics and biostatistics. Overall, about 85% hold a doctorate, and about 31% are women. In statistics, the percentage of women faculty is somewhat higher than in mathematics.

There are roughly 2.5 million undergraduate course enrollments in the departments covered by the Annual Survey. The estimated number of graduate course enrollments is 113,000 of which 48,000 (42%) are in statistics or biostatistics. In the 2015–16 report, roughly 32,400 undergraduate degrees were awarded in mathematical sciences, and 40% went to women. This number has trended upward from 2008–09 to 2015–16, and the percentage of women has held steady at about 41% over the most recent five of these years. An overall more rapid growth in master's degrees awarded has taken place over the same period, with on average year-to-year increases of 10% and over 7900 in 2015–16. See (Golbeck, Barr, & Rose, 2018c) for further details.

## **The Conference Board of the Mathematical Sciences (CBMS) Survey**

Every 5 years since 1970, under the aegis of CBMS, the AMS has conducted or managed a survey of undergraduate mathematical and statistical sciences programs in the US in 2-year colleges and 4-year colleges and universities. This CBMS Survey's objective is to provide as detailed a snapshot as possible of curricular

architecture, faculty demographics and their employment status, pedagogical strategies, and much more. Data are gathered from stratified random samples within these two groups of programs, and statistical conclusions are detailed in a technical report typically published about 2 years after respondents have completed the questionnaires.

A number of questions have been the same over time, permitting longitudinal comparisons of parameter estimates, and each Survey has also incorporated a number of special topics, which are determined in advance of the survey by a steering committee of educators that includes members of the statistical community. The 2015 CBMS Survey report appeared in early 2018 and is organized by:

- Special project topics (e.g, distance learning in various forms, secondary teacher certification requirements, types of upper-level statistics courses offered online, course and exit requirements for statistics majors, percentages of mathematics and statistics programs offering undergraduate courses in, e.g., Bayesian Statistics or Regression and Correlation).
- Bachelor's degrees awarded in mathematics and statistics, section counts by type of course, course enrollments, overall enrollments, pedagogical strategies, curricular structure, etc., in 4-year colleges and universities.
- Faculty demographics in mathematics and statistics departments of 4-year colleges and universities (training level [PhD or not], employment status [part-time, full-time, tenure-eligible, tenured]; breakdowns by gender, age, race, ethnicity, department/institutional type, etc.,)
- First-year courses in 4-year colleges and universities (enrollments, section counts, instructional staff characteristics, pedagogical strategies, and prerequisites for mathematics and statistics).
- Enrollments, course offerings, and instructional practices for mathematics and statistics in 2-year colleges.
- Characteristics of faculty in 2-year institutions (part-time, full-time, permanent, time in rank, continuing education/professional development requirements and support, etc.); and of administrative and curricular structure.

As of this writing, the AMS has received a NSF grant to support a CBMS survey in the fall of 2020 with the expectation that reporting will be complete and online data hosting fully in place by late 2022 or early 2023.

A unique aspect of the CBMS Survey is that it looks at undergraduate programs holistically, covering programs in every sort of not-for-profit institution in the US in which undergraduate courses are taught—PhD-granting, master's-granting, bachelor's-granting, and associates-granting. The perspective especially on 2-year (or community) colleges does not exist elsewhere in such a comprehensive form, and this component of the study has been part of this survey from the beginning. A few of the bright spots in the 2-year arena are highlighted here:

- In every instance of CBMS since its inception up until 2015, the percentage of full-time permanent faculty that are women has risen. In 2015, that percentage was 52% (Blair, Kirkman, & Maxwell, 2018), p. 198.

- In every CBMS survey since 2000, the number of full-time permanent faculty who are minorities has increased. The number had doubled in 2015, and the percentage had risen from 13% in 2000 to 23% in 2015 (Blair et al., 2018), p. 199.
- In 2015, new hires came principally from graduate school (37%), part- or full-time employment at the same college (26%), and teaching in another 2-year college (19%).

## Other Data Sources

The anecdote above about the STEM Inclusion Study illustrates the power and utility of a one-off, specialized study to shed light in an area not previously well understood. The chief disadvantages of this sort of statistically-based project is that it is expensive, and its results are not quickly available.

Useful existing resources are NCES/IPEDS, Bureau of Labor Statistics, Higher Education Research Institute, US Census, and the American Community Survey. In the contexts of much larger domains of human activity, these organizations provide ongoing related information about the “consumers” of the “services” provided by mathematical and statistical professionals. Seeing mathematics and statistics through such lenses helps to see how relatively small the academic mathematics and statistics community is.

As mentioned above, the ASA conducts its own academic salary survey, and it has also curated data from the NCES databases pertaining to the professional status of statisticians. Reports on these projects can be found in such resources as:

- Academic Salary Survey (Ange et al., 2019).
- Caucus Survey of Statistics and Biostatistics Departments (Caucus Survey of Statistics and Biostatistics Departments, 2008–2013).
- Statistics and Biostatistics Degrees (American Statistical Association, 2020).

Under the aegis of the National Science Foundation (NSF), the National Science Board (NSB) provides a great deal of detailed information about the US and international science and engineering enterprise. Its Science and Engineering Indicators (National Science Foundation, 2018) include much information about primary, secondary, and higher education activities in mathematics and statistics together.

Such organizations as the American Association of University Professors (AAUP) (2016) and the Council of Graduate Schools (CGS) provide publications and resources germane to the statistics and mathematics milieu. Also, the Chronicle of Higher Education publishes its well-known Almanac issue each year, and on its web site it hosts a wide range of “data interactives,” many of which are accessible without a subscription.

## **Limitations and the Future of the Annual and CBMS Surveys**

There are limits to these surveys—for instance, they provide little tracking of student outcomes beyond counts of various categories of graduate students, undergraduates, and degree recipients. In some instances, those limitations can be overcome by searching other sources, such as those mentioned above. Anecdotal evidence suggests that now more than ever, job opportunities for people with mathematical and statistical backgrounds abound, both in the “obvious” places such as Google, Facebook, and Amazon and also in many other smaller companies in other economic sectors. Tracking the employment experiences of bachelor’s, master’s, and PhD recipients, for the benefit of those running programs and for students earlier in the training pipeline, could have tremendous value. This step would require a fundamental rethinking of these two survey programs, shifting the focus from departments as the units of the surveys to individuals. To mount this effort would require significantly greater resources than are currently deployed.

Many of the parameters tracked in the Annual and CBMS Surveys change slowly, so the cycle on which some questions appear on survey forms might be lengthened in order to reduce the burden of answering the questionnaires.

An intriguing question is whether, say, after the current CBMS cycle, the two surveys might be combined into one. The prodigious every-5-year effort put into CBMS could be effectively spread over those spans of time. Also, reporting more frequently on 2-year programs could strengthen the impact, connections, and attention from the 2-year universe.

As with any survey, the problem of nonresponse is persistent, and in the present day, many are more reluctant than ever to respond to a questionnaire, even if it comes from a legitimate source and the results will be widely beneficial.

## **Evidence-Based Leadership: An Illustration**

Professional association committee meetings—especially those focused on policy for the organization—present opportunities that can be seized or squandered. As an ensemble, the committee can exercise true leadership by giving thoughtful consideration of evidence and make decisions that bind the organization to a certain course of action. But that opportunity can be squandered. For instance, the committee might act without information or thought at all, or at an opposite extreme it might mull over information without ever doing anything. The first shoot-from-the-hip approach turns the committee into something of a random number generator, so sometimes something beneficial occurs as a result, and other times either disaster or paralysis ensues. In the latter course of action, the committee might substitute for thoughtful action a mere scheme for gathering data without any follow-through; sometimes the sheer lust for data overwhelms other considerations.

In such instances, those individuals in titular roles of influence might show truer leadership by avoiding some of these pitfalls and attempting to engage in the following behaviors:

- **Listen and watch** Think about the professional community in the large, even as a business enterprise as suggested above, but at least with some model in mind. Back up momentarily from the locus of activity and look at it dispassionately, attempting to see it for what it is.
- **Engage in colloquy in the professional community** Talk with a diverse segment of the community—those who teach and those who learn and those who do research, women and men, minorities and majorities—about what others cherish and deplore about their working environments and the disciplines they embrace.
- **Do some homework** If questions or problems arise from conversations in the community, or even from mere listening and watching, look for sources of information, and spend enough time with enough of them to become more firmly grounded in parts of reality, and in where gaps exist. Devise a scheme for gathering data, if, as in the next step, imagination indicates how this exercise could be used in addressing a problem.
- **Exercise imagination** Engage in wishful thinking. Posit an ideal world in which the problem doesn't exist, as well as an arc from the present status to the ideal built out of conversations and homework. Augment, refine, or eliminate any nonactionable data-gathering plans.
- **Decide what is actionable** Do a reality check and see what's feasible to undertake to effect change.
- **Take action, track the consequences, and repeat this cycle as often as needed.**

Especially the homework, imagination, and actionability steps can incorporate long looks at data. A few keystrokes fed to a search engine might provide some starting points, but for deep dives, it may take time either to digest what the search engine serves up or to internalize a component of something as dense as an Annual Survey report. Living with the data long enough to begin hearing it speak is ideal. Taking the opposite approach, making a judgment and going to look for data that somehow bolsters that thought, is a weak way forward.

Here is an analogy. In the context of cryptanalysis, I have heard it said, “Don't force the plaintext.” This nugget of wisdom could be of value to someone who is confronted with an enciphered message that is to be cracked. With a hunch about the original plaintext, but without the key information that would make inverting the encryption function easy, the cryptanalyst could let the hunch figure too prominently. Those persons might *force* the cryptanalysis to yield the message they want or expect. Instead, the advice says, let the data coming out of the cryptanalysis *lead* the effort. Patience, persistence, and listening raise the chances that the cryptanalyst is drawn to a likely valid conclusion. A leader is like the cryptanalyst, trying to discern the “real” message from a concatenation of inputs directly from people and indirectly from data sources. Embedded in the data is information that will serve to lead the leaders in action steps. Such an approach can work for various styles—building consensus, modeling behaviors, or even command-and-control—

and thoughtful use of real information will pave the way to better action in support of the community's greater good. The consideration of evidence deeply enough to feel led to action steps is essential.

## **An Action-Oriented Recap**

How can such resources such as Annual and CBMS Surveys be useful in promoting diversity and inclusion? In what ways can they influence systems and climate? How can they be used to develop a culture that works toward the greater good in society and the fuller engagement of people in the efforts of research, teaching, and succession? Here are a few suggestions for readers:

- Take time to look at these reports, and try to absorb some of the detail as well as the overall picture. Tell others about them. In short, promote them: you can easily make a difference just by raising awareness about the forms and extent of participation in the academic community.
- Particularly, if you are a chairperson or other department leader, use these reports to inform your discussions with faculty in your department, and with others in your institution with whom you share responsibility for programmatic development and change.
- At the institutional level, consider your department's succession planning in light of the status and trends in the larger arena.
- Engage with the committees that advise these projects—the Joint Data Committee and the CBMS Survey Steering Committee. Approach them with your questions and ideas. Current membership lists are on the AMS web site.
- Watch for and read future reports from such projects as the STEM Inclusion Study and the 2020 CBMS Survey project.
- Approach ad hoc offers coming your way with imagination—as illustrated by the STEM Inclusion story. Think carefully about how someone else's efforts may be leveraged to provide what you want.
- Explore and use other sources mentioned here.
- When the Annual Survey or CBMS Survey questionnaires arrive, respond to them, or see that the right person in your institution responds!

## **Appendix: List of CBMS Member Societies**

Established in 1960, CBMS is currently an umbrella organization for 17 professional societies, listed here, that support “the increase or diffusion of knowledge in one or more of the mathematical sciences:”

AMATYC	American Mathematical Association of Two-Year Colleges
AMS	American Mathematical Society
AMTE	Association of Mathematics Teacher Educators
ASA	American Statistical Association
ASL	Association for Symbolic Logic
AWM	Association for Women in Mathematics
ASSM	Association of State Supervisors of Mathematics
BBA	Benjamin Banneker Association
IMS	Institute of Mathematical Statistics
INFORMS	Institute for Operations Research and the Management Sciences
MAA	Mathematical Association of America
NAM	National Association of Mathematicians
NCSM	National Council of Supervisors of Mathematics
NCTM	National Council of Teachers of Mathematics
SIAM	Society for Industrial and Applied Mathematics
SOA	Society of Actuaries
TODOS	TODOS: Mathematics for ALL

## References

- American Association of University Professors. (2016, March–April). Annual Report on the Economic Status of the Profession, 2015–16: Survey report tables. *Academe*, 102(2), 01902946.
- American Mathematical Society. (2020). *Find a Graduate Program in Mathematical Sciences*. Retrieved from <http://www.ams.org/programs/students/findgradprograms/findgradprograms>.
- American Statistical Association. (2020). *Statistics and biostatistics degree data*. Retrieved from <https://www.amstat.org/asa/education/Statistics-and-Biostatistics-Degree-Data.aspx>.
- Ange, B., George, V., LaLonde, D., & Wasserstein, R. (2019, June). 2018–2019 academic salary survey. *AMSTATNews*. Retrieved from <https://magazine.amstat.org/blog/2019/06/01/2018-2019-academic-salary-survey/>.
- Blair, R., Kirkman, E. E., & Maxwell, J. W. (2018). *Statistical abstract of undergraduate programs in the mathematical sciences in the United States: Fall 2015 CBMS survey*. Providence, RI: American Mathematical Society. Retrieved from <http://www.ams.org/profession/data/cbms-survey/cbms2015>
- Caucus Survey of Statistics and Biostatistics Departments. (2008–2013). Retrieved from <https://www.amstat.org/ASA/Membership/Caucus-Survey-of-Statistics-and-Biostatistics-Departments.aspx>.
- Cech, E., & Waidzunas, T. (2011). *STEM Inclusion Study*. Retrieved from <http://www.steminclusion.com>.
- Conference Board of the Mathematical Sciences (CBMS). (2019). Retrieved from <https://www.cbmsweb.org>.
- Givens, W. (1957, December). Report of the committee to investigate the present economic status of teachers. *Notices of the American Mathematical Society*, 4(6), 30–35. Retrieved from <http://www.ams.org/profession/data/annual-survey/1957Survey-Report-Salaries.pdf>.
- Golbeck, A. L., Barr, T. H., & Rose, C. A. (2018a, December). Recruitment, hiring, and attrition. *Notices of the American Mathematical Society*, 64(11), 1431–1435 Retrieved from <https://www.ams.org/journals/notices/201811/rnoti-p1431.pdf>.



- Golbeck, A. L., Barr, T. H., & Rose, C. A. (2018b, August). 2017–2018 faculty salaries report. *Notices of the American Mathematical Society*, 65(7), 829–835. Retrieved from <http://www.ams.org/2017Survey-FacultySalaries-Report.pdf>.
- Golbeck, A. L., Barr, T. H., & Rose, C. A. (2018c, September). Fall 2016 Departmental Profile Report. *Notices of the American Mathematical Society*, 65(8), 949–959. Retrieved from <http://ams.org/profession/data/annual-survey/2016Survey-DepartmentalProfile-Report.pdf>.
- Golbeck, A. L., Barr, T. H., & Rose, C. A. (2019a, August). Report on the 2016–2017 new doctoral recipients. *Notices of the American Mathematical Society*, 66(7), 1151–1160. Retrieved from <http://ams.org/profession/data/annual-survey/2017Survey-NewDoctorates-Report.pdf>.
- Golbeck, A. L., Barr, T. H., & Rose, C. A. (2019b, August). Report on the 2016–2017 employment experiences of the new doctoral recipients. *Notices of the American Mathematical Society*, 66(7), 1161–1165. Retrieved from <http://ams.org/profession/data/annual-survey/2017Survey-NewDoctorates-Report.pdf>.
- Grundman, H. (2018, November 29). The STEM inclusion study: What we've learned so far. *inclusion/exclusion Blog*. AMS. Retrieved from <https://blogs.ams.org/inclusionexclusion/2018/11/29/the-stem-inclusion-study-what-weve-learned-so-far/>.
- Integrated Postsecondary Education Data System (IPEDS), National Center for Education Statistics (NCES), US Department of Education. (2019). Retrieved from <https://nces.ed.gov/ipeds/>.
- National Center for Educational Statistics. (2011). *Profile and financial aid estimates of graduate students: 2011–12*. Retrieved from <https://nces.ed.gov/pubs2015/2015168.pdf>.
- National Science Foundation. (2018). *Science and Engineering Indicators*. National Center for Science and Engineering Statistics, National Science Board, National Science Foundation. Retrieved from <https://nsf.gov/statistics/2018/nsb20181/>.

# “And Oh the Stories We Could Tell”: Why Numbers Need a Narrative



**Brian Tarran**

**Abstract** Data scientists and statisticians must learn to harness the power and potential of storytelling: whether their goal is to lead a project, inspire change within a team, forge a new path for their organisation, or communicate effectively with the public and policymakers.

Forty-two, the answer to the “Ultimate Question of Life, the Universe, and Everything”, is a disappointment. A let down. A damp squib of a revelation. But deliberately so. Douglas Adams, author of *The Hitchhiker’s Guide to the Galaxy*, the book in which this answer is given, always meant it as a joke. In 1993, he explained: “It had to be a number, an ordinary, smallish number, and I chose that one . . . I sat at my desk, stared into the garden and thought, ‘42 will do’. I typed it out. End of story”(Bignell, 2011).

End of story for Adams, perhaps. But for years, readers have sought to ascribe meaning to his choice of number. Adams had dismissed various different theories as “complete nonsense” prior to his death in 2001 (Bignell, 2011), but reader fascination was undiminished. Ten years after his death, an entire book was published dedicated to reasons why 42 should be considered significant (in the non-statistical sense) (Gill, 2011).

We should not be surprised by this. The search for meaning, for explanation, is a powerful driver of human activity. It inspires scientific investigation, journalistic reporting, and religious study and belief—even mundane water-cooler chats about bizarre or disturbing dreams. Confronted with something new, unknown or unexpected, we can’t help but wonder “why”. We try to make sense of it.

The search for meaning is particularly acute in the case of 42 for one simple reason: it is a number. Devoid of context, it is meaningless. Deep Thought, the computer that spent millions of years working it out, knew the answer to the “Ultimate Question”, but the question itself was unknown. Thus, the reader—and

---

B. Tarran (✉)  
Significance Magazine, London, UK  
e-mail: [B.Tarran@rss.org.uk](mailto:B.Tarran@rss.org.uk)

the characters in the story—are left with the *what*, but not the *why*. And without the *why*, we—and they—have nothing we can make sense of.

Forty-two, the answer to the “Ultimate Question of Life, the Universe, and Everything” puts paid to the idea that numbers speak for themselves. They do not.

## Context Is Everything

Let’s try another number. Seventy-six. What does it say to you? Nothing, most likely. What if I tell you it’s a percentage? Then, you’ll probably want to know, “a percentage relating to what?”. I can tell you that it’s the estimated UK employment rate for February to April 2019, but that is still not enough information to make sense of the number (Office for National Statistics, 2019). You’ll no doubt be asking: How is the employment rate calculated? Is it the percentage of all those old enough to work? Capable to work? Willing to work? Is 76% a big number? Should it be higher or lower?

That last question is particularly hard to answer through numbers alone. We could compare the UK employment rate with the French or German employment rate and look at the similarities and differences. But whether a high employment rate is desirable or not depends entirely on a country’s political values and goals, on the sort of country it wants to be, and what proportion of its working-age population it wants to see in work, in higher education, in vocational training, engaged in voluntary activities, etc.

“Context is everything,” says Anthony Reuben, the BBC’s head of statistics, and author of the book, *Statistical: Ten Easy Ways to Avoid Being Misled by Numbers*. “If you don’t know what the figure was last time or what it is in another country, then you just have a number and no particular idea whether it’s big or small and whether it can safely be ignored.”

Once again, we see that numbers do not—cannot—speak for themselves. “There’s nothing manifestly meaningful about numbers, data, or statistics,” says Rebecca Goldin, a professor of mathematical sciences at George Mason University. “They become important because they have meaning to humans.

“Very few people care about statistics in the abstract,” she says. “Most people want to know what it *means*. In other words, they want the story.”

All statistics—all data, in fact—can be seen as the product of a story, one that starts with a question—something we are curious about and seek to understand. Curiosity leads to investigation, to data collection and analysis, and to an eventual answer. It might not be the answer we expect, but it’s an answer nonetheless.

When confronted with numbers, data, and statistics, most people “want the story” because meaning is imparted through story. Stories are how we make sense of the world.

“When I think ‘story’ I think of ‘the big story,’” says author, illustrator, and designer RJ Andrews, “and by that I mean the story we tell ourselves in our own

head about how the world works and how we are going to interact with the world. So, when I think of any kind of story, I first think of it as a model of understanding.”

Each of us has our own stories—our own models of understanding—about our lives, our families and jobs, and our place in the wider world. Numbers, data, and statistics have their own stories as well, but they can also form part of our individual stories; they are inputs that help us develop our sense of who we are, the society in which we live, and all manner of things that are important to us.

Both Goldin and Andrews understand the importance of story: Goldin as someone who, through the STATS initiative, trains journalists to work with data; Andrews as a professional data storyteller who has worked with academics to help them bring their insights to life, on page and on screen. But such appreciation for story is not what you would call commonplace in science more generally, nor statistics specifically.

Andrews says: “In my experience, the traditional, conservative – maybe classical – academic community is pretty resistant to the word ‘story’, because they connect it directly to the word ‘propaganda’, meaning ‘I am going to manipulate you’.”

Goldin sees something similar in her own experience. She says: “The scientific community is generally nervous about stories and with good reason. History is riddled with examples of horrible outcomes when people make decisions on stories alone. Individual outcomes often convince people more than statistical analysis of a collection of outcomes.”

We see evidence for this in the current vaccine scare, says Goldin. “People whose children have developed autism symptoms soon after having vaccines are quick to conclude that vaccines caused autism.” But she says, “Only an analysis of many children with vaccines occurring at different times can provide evidence that autism symptoms are typically observed in the same time period as vaccines are given, with no causal relationship between them.”

Here, with the vaccine scare, we see what happens when a powerful story about children supposedly in danger overrides science: it leads to the return of childhood diseases once thought banished (Hotez, 2019) and a weakening of herd immunity in certain parts of the world (Bedford, 2019). But the solution is not to dismiss stories as dangerous and to make a cold appeal to rationality instead (to encourage worried parents to just take a closer look at the published data, perhaps). Rather, science needs to engage with the public on the same terms. It needs to find its own, more compelling story.

This point was made recently by the investigative journalist James Ball, formerly of *The Guardian* and BuzzFeed. Speaking at the Royal Statistical Society Conference in September 2019, Ball criticised statisticians, fact-checkers, and reporters—himself included—for spending too much time during the UK’s fraught “Brexit” referendum campaign trying to explain why one particular claim—about how much money the UK sends to the European Union each week—was wrong. He said:

We all got caught up on thinking we were brilliant, taking apart this stuff, fact-checking it, really doing some responsible journalism – and most of what a normal person would hear was, ‘Remain and the experts say we send £175 million a week to the EU; Vote Leave says it is £350 million a week. It’s probably somewhere in the middle’ . . . We didn’t tell a true story that beat the false one, we just kept trying to make the false one really boring . . . (Tarran, 2019).

Of course, the boring story convinced no-one—or, at least, too few people to matter—so we shouldn’t be surprised that the UK’s Remain campaign lost to the Leave campaign. The actual amount of money wasn’t important, it was the story behind it that resonated: a promise to take back that which belonged to “us” and to spend it on “our” country instead.

Writing in *Politico*, the former director of communications for Vote Leave explained: “Our strategy was to lay out an alternative vision for government by detailing policy suggestions that could be pursued after a Brexit vote, including extra funding for the NHS, a cut in VAT on fuel and an Australian-style points based immigration system” (Stephenson, 2016). This vision—whether you agree with it or not—told a clear, emotive, and engaging story about the future of Britain, and the story resonated with voters. As two political scientists put it:

The Leave narrative was situated in a romantic setting that provided the stage for telling a story about an exciting and emotional quest to exit the EU . . . Specifically, they conjured up a sense of excitement in depicting the referendum as a unique opportunity to effectuate positive change that must not be missed (Spencer & Oppermann, 2019).

This is the power of storytelling. Political leaders understand it and harness it, and so too do business leaders. As the business author and columnist Steve Denning describes it in one of his *Forbes* columns:

Storytelling is often the best way for leaders to communicate with people they are leading. Why? It is inherently well adapted to handling the most intractable leadership challenges of today – sparking change, communicating who you are, enhancing the brand, transmitting values, creating high-performance teams, sharing knowledge, taming the grapevine, and leading people into the future (Denning, 2011).

In addition, Denning says, storytelling “translates dry and abstract numbers into compelling pictures of a leader’s goals”. A good business case might be based on numbers, says Denning, but “they are typically approved on the basis of a story – that is, a narrative that links a set of events in some kind of causal sequence”.

This lesson, about the power and potential of storytelling, is one scientists and statisticians would do well to learn: whether their goal is to lead a project, inspire change within a team, forge a new path for their organisation, or communicate effectively with the public and policymakers.

“Numbers, data, and statistics can frame a story, contradict a story, or simply nudge it in a different direction,” says Goldin. But numbers alone are not enough. As the psychologist Daniel Kahneman has said: “No one ever made a decision because of a number. They need a story” (Lewis, 2016).

And creating an effective story requires an understanding of the fundamentals of storytelling.

## Narrative Structure

“Storytelling is an indispensable human preoccupation, as important to us all – almost – as breathing,” says the British screenwriter John Yorke in his book *Into The Woods: How Stories Work and Why We Tell Them* (Yorke, 2014). In seeking to explain why humans find stories so compelling, Yorke argues that the typical dramatic structure of a story is “not a construct, but a product of human psychology, biology, and physics”.

That structure—whether over three or five acts (or more)—involves an inciting incident, followed by a journey, a crisis, and a climax. An archetypal story, Yorke says, introduces a central character, one the readers are invited to identify with. Something then happens to that character (the inciting incident), and “[t]he story is the journey they go on to sort out the problem presented”.

Along the way, Yorke says, “they may learn something new about themselves; they’ll certainly be faced with a series of obstacles they have to overcome; there will likely be a moment near the end where all hope seems lost, and this will almost certainly be followed by a last-minute resurrection of hope, a final battle against the odds, and victory snatched from the jaws of defeat”.

The typical dramatic arc can also be thought about in terms of the “hero’s journey”: a 12-step story outline that involves a call to action, an adventure, discovery of new knowledge or new power, and a return home, with the hero now wielding that new knowledge or power.

Yorke’s book shows clearly how the same underlying pattern manifests in all different types of stories, involving all kinds of heroes (and anti-heroes)—from *Toy Story* to *The Godfather*—and he believes that “[t]he endless recurrence of the same underlying pattern suggests psychological, if not biological and physical reasons for the way we tell stories”.

“In simplistic terms,” Yorke writes, “human beings order the world dialectically. Incapable of perceiving randomness, we insist on imposing order on any observed phenomena, any new information that comes our way. We exist; we observe new stimuli; and both are altered in the process. It’s thesis, antithesis, synthesis.”

Though it may not be obvious, this archetypal story structure can be applied to stories about numbers, data, and statistics. And the hero’s journey is relevant, too, whether or not scientists and statisticians wish to cast themselves in the role of “hero”.

Yorke helpfully makes the connection for us, comparing story structure with the process by which we learn as students. He writes: “Students encounter something of which they’re unaware, explore, and assimilate it, and by merging it with their pre-existing knowledge, grow. Every act of perception is an attempt to impose order, to make sense of a chaotic universe. Storytelling, at one level, is a manifestation of this process.”

RJ Andrews goes a step further in his book, *Info We Trust*, drawing direct parallels between the hero’s journey and the investigation and analysis of data (Andrews, 2019). He writes: “Each time you wade into a dataset, make some sense

of it, and relay that information to the world, it is like a micro-dose of the hero's journey. You choose to confront the chaos of the unknown in the hopes of delivering some order to society."

Stories are compelling, then, because their typical shape and progression mirror the ordered process we go through to make sense of the world. Or, as the comedian and broadcaster Timandra Harkness says: "The reason we love stories is that they reflect our own experience back to us but with more structure."

But good stories are not merely engaging. They serve a purpose. They help us to convey ideas, to share knowledge, and to make a point and have it stick. Andrews makes a distinction here between "story" and "narrative". Stories, he says, are models of understanding, and narrative "is a very effective way of conveying and trying to explain and reproduce your model of understanding in somebody else's head."

This transfer of understanding through narrative goes on all the time. As Rebecca Goldin says: "We use stories to explain to children why they should be 'good', why they should learn to read, or why they should try their best. When we speak to our friends, we tell them stories of our lives . . . These stories drive the way we hook our audiences. In some restricted circumstances, our goal is only to communicate information rather than a story, like when we say 'the milk costs \$2.80 per gallon'. But most of our communication, with all different kinds of audiences, involves storytelling of various forms."

So, how do we apply narrative structure to stories about numbers, data, and statistics?

## First Steps

The first thing to recognise is that all stories seek to take the reader on a journey. The journey itself—where the characters go, what occurs, and where they end up—doesn't particularly matter as it varies from tale to tale. What really matters is that the story is compelling enough that the reader will stick with the journey through to the end. The beginning of the journey, then—that first introductory step on the road to adventure, mystery, and discovery—is all important. And it is a step academics often get wrong.

The *Wall Street Journal* columnist, Jo Craven McGinty, gave examples of this at the 2017 Joint Statistical Meetings in Chicago, comparing the introductory paragraphs of scientific papers with her own introductory paragraphs based on said papers. Consider the following:

With the rapid expansion in the availability and use of household credit over the past three decades, credit scores have become more ubiquitous in households' financial and non-financial decisions and opportunities. For example, credit scores are a feature of all mortgage and consumer lending and thus affect households' access to credit, the pricing of credit, and their ability to smooth consumption over the lifecycle or against income fluctuations. Credit scores also frequently extend to other areas besides debt and

underwriting, such as auto insurance contracts, cell phone plans, and rental housing. Moreover, survey evidence suggests that up to 60 percent of employers run credit checks on potential employees as part of the hiring decision.

Motivated by the growing prominence of credit scores, we explore their role in partner selection and relationship dissolution using a large, proprietary dataset (Dokko, Li, & Hayes, 2015).

There are 138 words in those paragraphs, 114 of them superfluous to the question the paper seeks to explore: Do credit scores play a role in the making and breaking of romantic relationships? Here’s McGinty’s version:

Does your Valentine make you laugh? Is she easy to talk to? If so, that’s great. But if you’re looking for a long-term relationship, researchers at the US Federal Reserve say a credit score may be a better measurement of compatibility (Craven McGinty, 2016).

McGinty gets to the point in a breezy 41 words. Sure, her version lacks background information and a certain amount of context. But that doesn’t matter. She has engaged the reader and tried to make the subject relevant and relatable. She has brought them into the story. Writer and reader have taken the first step on a journey together.

Timandra Harkness recognises the importance of beginnings. Her mother was a storyteller, and the two used to train scientists and engineers in the art of storytelling. “We spent a lot of time looking at how to begin [a story], and my mum had a series of methods that we would get people to try. The simplest one was to have them say, ‘This is a story about . . .’. Or you could have them ask a question. Or you could set the scene and take people somewhere using their senses, because then you have transported them to a world you have created, and they are going to stay in that world as long as you give them reasons to.”

The traditional fairy-tale beginning, “Once upon time . . .”, is perhaps not a natural fit for stories based on data. But there are other ways to open up a story, whether that be establishing a mystery to be solved later on, or an unexpected discovery that requires an explanation, or some tension or jeopardy or looming tragedy that needs to be averted. “These are just very emotionally sticky and gripping things for people,” says Harkness. “They will pay attention until you finish telling them stuff, and they will remember [what you tell them] because stories stick in our memory much better than odd, stray facts.”

Another way to engage an audience, as Yorke says, is to introduce a character that readers are invited to identify with. It is a common storytelling technique, one particularly employed by journalists as it can be highly effective.

A case in point: it is somewhat of a surprise to me that one of my favourite non-fiction books is about nuclear weapon safety systems and risk assessments. It sounds dry and technical, and certainly not the sort of thing I’d typically enjoy, but the book in question—*Command and Control*, by the journalist Eric Schlosser—wraps its exploration of the subject around the tense and tragic story of the 1980 Damascus Titan missile explosion, and the people that faced it head-on (Schlosser, 2013). The opening chapter begins with Senior Airman David F. Powell and Airman Jeffrey L. Plumb walking into a Titan II missile silo for routine maintenance. It ends



with a falling socket wrench, a spray of fuel from a hole in the missile, and Plumb's exclamation: "Oh man. This is not good."

Schlosser's book works so well because it intercuts the human with the technical, zooming in and out repeatedly from a small, single frame of lived experience to the bigger picture, so that, over time, the whole story comes into focus.

Thus, part of the challenge of journalism—and storytelling more generally—is finding a simple way to capture the idea you want to discuss and have it draw people in, says Richard Campbell, professor of journalism at Miami University, Ohio, and co-host of the Stats and Stories podcast. Campbell recalls a visit to the university several years ago by Nicholas Kristof, a *New York Times* columnist. Kristof "talks a lot about really complicated stories in Africa, a lot of stuff about poverty," says Campbell, "and [I remember him saying] 'The only way in my columns I can really draw people in is I have to start with the story of a single person or single family. I'm not going to get them interested in the science or the data if I start the story that way; I'll overwhelm them.'"

This journalistic approach, this way of thinking about and structuring story, is different to how a mathematician or statistician might tackle the same problem. In her work with STATS, Rebecca Goldin has had the opportunity to compare and contrast the two approaches. She says:

A journalist might view the starting point of a story through a social lens, leaving the data collection/analysis as a distant secondary effort. For example, a journalist might be interested in whether children with disabilities are discriminated against in public schools. They would interview a few families whose kids with disabilities were not allowed on a field trip, can't get the support they need in a particular educational program, or suffered some "unfair" disciplinary action. Journalists would look up the legal guidelines, if any. They might go to a Parent-Teacher Association meeting and ask around whether discrimination against children with disabilities is a concern for other parents.

If they establish that discipline is a strong arena to document discrimination, they may talk to a principal about a school-wide or county-wide policy on disciplinary actions. The journalist may then submit a Freedom of Information Act request to get the data on in-school and out-of-school suspensions for children across a county and compare rates for disabled children with children who do not have disabilities. With all these sources in hand, they would then write a story about disciplinary discrimination.

The hook – often the lead paragraph for the story – would be a "what happened" story that readers could relate to: how "Penny" was pushed out of school and disciplined in a discriminatory way for behavioural problems related to her disability. The article would include a quote from Penny's parents about how frustrated they are with the school. It may also include a quote from a parent who said something obnoxious like, "those kids are already getting all the teachers' attention". Data would be reported as an additional source, backing up the claim of disparity.

A typical mathematician might be more likely to start from a search for data. From the scientists' point of view, you can't know there's discrimination without enough data on children with disabilities and on children without disabilities to make comparisons. They would then look at the data to see what kind of discrimination may have left documented evidence. This might be when they also decide to write a story about disciplinary actions and whether they are higher among children with disabilities than among children without such disabilities. The "story" would not necessarily be anchored in an individual personal story. If these math-y people found such a story, it would be presented after the data, as an exemplary case reflecting the data.

Goldin points out that these are broad characterisations. But there are enough examples of each type of approach—in newspapers and academic journals, respectively—to know that they are not exaggerations.

John Bailer, professor and chair of the Department of Statistics at Miami University (and Campbell’s Stats and Stories co-host), has experienced a change in his own thinking about story in recent years, and the change underscores this difference in approach.

“If we were talking about this 30 years ago, I would have probably said, ‘If you’ve got a strong analysis, that should convince you to change’,” says Bailer. “But now I realise that that is a complete fiction; that, basically, people are not going to be convinced by data. The data and analysis are not going to be the compelling part of this. They can be a clear and critical component of how we know something is true, but it’s the story and the narrative around that that’s going to matter or help inspire change.

“That’s been a huge part of my change of perception and thinking,” says Bailer. “If you want to think about the importance of data and analysis, and how they might impact attitude, behaviour, and policy, there has to be a strong story that resonates with the people hearing it.”

Regina Nuzzo is another statistician who thinks this way. After completing a PhD in statistics at Stanford, Nuzzo did graduate training in science writing at the University of California, Santa Cruz. Her career since has involved teaching statistics (as a professor) and writing about statistics (as a freelance writer), both of which have shaped her ideas about the importance of what she calls “human-centred quantitative communication”.

“The idea is that when we need to communicate quantitative information, we need to work with what’s on the receiving end – and on the receiving end is a lovely hunk of meat shaped by evolution and limited by biology,” says Nuzzo. “Stories are hard-wired in us. Numbers are, too, to a certain extent – but stories have the fast-track to our gut. If you wrap numbers in stories, then you have a winning combination!”

So what will it take to make Nuzzo’s vision of human-centred quantitative communication a reality?

## **Be Human**

First things first: academics need get over their “resistance” towards story. Crucially, says RJ Andrews, they need to confront one major blind spot: “What they don’t see is that they are already telling stories, and the stories they are telling are pretty crappy and ineffective . . . In the most severe sense, they are shirking their responsibility as storytellers by denying that they are playing any storytelling role at all.”

Most scientific communication is through the medium of the scientific paper, which the late American biologist Bernard Davis described as “an unusual art form”.

It has to be as compact as possible, while giving the reader all the information needed to repeat the experiments. Because the literature is vast, the format of a paper is standardized so the reader can quickly find the parts that interest him; readers skim most of the papers that they look at, except those very close to their interests. The aim is efficient, impersonal transmission of the essentials, rather than a narrative account of the steps along the way (Davis, 2000).

Thought of like this, the scientific paper is simply a “how-to” guide or manual, and if everyone were a scientist, such guides would be of roughly equal importance to us all. But we are not all scientists, and for those of us who aren’t, the scientific paper offers little value—not least because the form of the paper itself, and the language used, can be impenetrable.

“There are a number of ways in which academic storytelling fails,” says Andrews. “One is that it is written for an elite audience, other ‘academagicians’ – this priestly class of people that have this archaic way of talking between themselves. Further to that, these archaic forms of expressing things are kept behind locked doors (although that’s obviously not the future). And so, if you think about stories . . . if we say that academic insight is a story, well, guess what? All those stories are in a weird, dead language and they are locked away in a tower. And that’s a big problem from my perspective.”

This problem is not one to be solved by doing away with the scientific paper—it serves a purpose and plays an important role within science itself. Rather, the problem is that relatively few scientists attempt to communicate much beyond the scientific paper, or that, when they do, they remain beholden to the structure of traditional academic “storytelling”.

I experience this first-hand, most days of the week. As the editor of a magazine that seeks to explain and present statistics and statistical ideas in an accessible, engaging way, I receive frequent submissions from academics looking to popularise their work and reach a broader audience than they might otherwise find through a more traditional journal. Yet, more submissions than I care to count still stick to the established format of a scientific paper—abstract, background, data, method, results, and discussion—and remain wedded to the idea that “efficient, impersonal transmission of the essentials” is the overriding goal.

To make statistics accessible and engaging, our magazine aims to tell stories. And stories, as we now know, are most successful when they capture and reflect something of the process we all go through when learning about the world: the call to action, the adventure, and the discovery of new knowledge or power.

This is the scientific process in narrative form: Each investigation is prompted by an “inciting incident”—a question to be asked, a mystery to be solved. The data collection process is its own journey “into the woods”, to quote the title of John Yorke’s book—an adventure perhaps leading to something unexpected. Through analysis, the scientist seeks to make sense of the new knowledge they have acquired, testing it against their old assumptions about the way the world works. And finally, there is the triumphant return home, with new knowledge in tow, ready to be shared and to help remake the world.

But you wouldn’t get all that from reading a scientific paper.

To tell compelling stories about numbers, data, and statistics, scientists must recognise the human element within their work and bring it to the fore. After all, “humans collect data, describe data, analyse data, use data to make predictions or to figure out what’s going on,” says Rebecca Goldin. And although the basic objective of scientific writing is to try to take the observer out of the picture, scientists should acknowledge that this is a “slightly fictitious process”, says Timandra Harkness, “because who does the science? It’s human beings.”

Humans are so inclined to make stories out of anything that “we turn everything into characters,” says Harkness. “Think of how you have conversations with your computer when it won’t do what you want, and you swear at it, and suddenly you are locked in an elemental struggle – human being against computer – and you’ve ascribed this character to your computer as your adversary, and we know that’s not true, but it makes it more dramatic, it makes it more interesting.”

“So, even though storytelling doesn’t necessarily feel like a natural fit with statistics, if you realise how often we turn everyday things into stories for ourselves, then you will see that if something is interesting enough for you, as a statistician, to look at, there is some kind of a story there that will make it more interesting to other people.”

The “other people” that Harkness refers to, of course, are the audience—perhaps the most crucial component of the storytelling experience. (Is a story even a story if there’s no-one around to hear it?)

In our magazine’s notes for contributors, we state early on: “Please keep our audience in mind while writing.” And there is good reason for this. A story is only interesting and engaging if it is interesting and engaging for the people reading or hearing it. The challenge facing the storyteller, then, is not only to find a story they think is interesting but also to figure out why it might be interesting to others.

Alex Blumberg, the CEO and co-founder of the podcast company Gimlet Media, has a tool for this, called the “XY Story Formula”. Here’s how it works, according to the author Jessica Abel: “You tell someone, out loud (and the out loud part is important – you have to hear yourself talk): ‘I’m doing a story about X. And what’s interesting about it is Y’” (Abel, [n.d.](#)).

Y, Abel says, “is that special sauce that makes [a] particular person, event, or subject, worth our consideration”. You could also call it the “so what?” problem. Or, as John Bailer at Stats and Stories puts it: “Why should I care?”

As Abel rightly points out, “Your audience is always thinking, What’s in it for me?”. Even you, reading this chapter now, may be thinking the same thing. So far, we have explored some of what story is, how stories work, and how certain elements of storytelling might be applied to numbers, data, and statistics. But, as yet, we’ve not broached our own “so what?” problem; we have not answered the fundamental question: Why should scientists and statisticians want to get better at telling stories?

## The Good of Science

“This is a wider problem that affects science communication in general, that question of, ‘Why is it my job to explain my research?’” says Trevor Butterworth, a former journalist and executive director of Sense About Science USA.

Butterworth has spent a number of years, through Sense About Science USA and the STATS initiative, trying to bring statisticians and journalists together, to get stories about data into the news and to help develop greater statistical literacy among reporters and, by extension, the general public.

“One can make all manner of appeals to the public good, to the good of science,” says Butterworth. “Whether they will exert a moral obligation on you, as a statistician, to actually communicate is entirely random.”

Butterworth believes that the decision on whether or not to engage in science communication ultimately comes down to the individual and their view of the relationship between science and the public good. “If you think that, ‘Actually, it’s not in my personal interest to try to communicate this because I don’t see it having any public benefit’, then there are no foundational premises I can point to to convince you logically otherwise,” says Butterworth.

But even if a scientist or statistician *does* believe in the importance of effective, engaging communication, it’s not clear whether sufficient incentives exist within academia to reward those willing to take the time to get better at storytelling. And good stories do take time to develop, says RJ Andrews. “People do not appreciate how hard it is to tell a good story and how much work it requires,” he says. “They might know that [storytelling] is important, but they are never going to put anywhere near the amount of effort to learn how to do it – or provide the resources, the time, the budget, to actually produce a compelling story.”

It is the iterative nature of storytelling that takes the most time. Blumberg’s XY Story Formula isn’t something you work through once; the Y must be repeatedly refined to tease out the right form of story that the audience will be interested in. As Andrews says: “You are going to try something and see what works well and then you are going to refashion it. This is how all great storytellers create interesting stories: they really have to pay attention to their audiences and see what works and what doesn’t and refashion the story.”

Does science, as a career, allow time for that? Are researchers given space to refine their story and help it reach the right audience? Or, once a paper is published, do they have to move quickly on to the next idea, the next round of funding bids, the next investigation?

Clearly, some researchers do have the time and space to pursue storytelling and public engagement. There are the Brian Coxes and Hannah Frys of the world—the “megastar” science communicators. And we should also bear in mind that some of the best science writing today can be found on the websites, YouTube channels and blogs of working scientists. They may not be recognisable names like Cox or Fry, but they are making the effort to explain their work.

Over the course of his career, John Bailer believes there has been a change of attitude towards the value of communication in academia. “My preparation to be a communicator to a lay audience was pretty much non-existent,” he says. “Within my formal training in my discipline, it was pretty much the production of technical work for technical audiences.” But that experience? “I don’t think that’s replicated now,” he says. “In programmes today, there is much more enthusiasm and engagement with this topic of, ‘How do we make sure our graduates are going to be effective communicators?’”

Part of what’s driving that, he says, is a recognition of what employers are looking for in graduates. “At a very simple level, it is more than just the technical competencies; it’s the ability to interact with broader teams that have disciplines represented that aren’t the same as yours.” Bailer’s colleague, Richard Campbell, meanwhile, sees “a political element in this, in that, in some [US] states, there is an obligation for universities, especially public universities, to be able to explain to the politicians who allocate money just what it is they are doing, and I think there is a growing sense that universities have to be better at this. You can’t just have your isolated research project and expect it to be funded at a high level if you can’t explain this to state legislatures.”

But, setting all this aside, there is one overarching reason for scientists and statisticians to refine their storytelling skills. As Butterworth says, science has a credibility problem right now, and this problem is exacerbated by changing attitudes towards expertise in society. “The public are prone to reject top-down explanations for things . . . they are excluded from the process by which decisions are made,” says Butterworth. “It’s an argument we see a lot of now, both on the right and the left, but you see this also in the counter-culture movement of the 1960s—the rejection of the scientific method, the sense that people were being ruled by a technocracy that were making very complex decisions behind the scenes in obscure ways that people couldn’t understand, and that there was a sense people needed to seize control. Well, people have kind of seized control, and you see that in the latest Wellcome study on vaccination mistrust (Gallup, 2019), they are seizing control by seizing on to lots of garbage information.”

Statistics can help people “to extract the good from the bad in this chaos of information”, says Butterworth. But they need to be shown how to do this, and—most importantly—they need to be able to take meaning from the numbers they encounter.

## Keep Trying

“What does it mean to be an informed citizen?” asks Bailer. “You need to be an informed consumer of information, you need to have these kinds of skills when you are going to a doctor and they are talking about the risks, the probabilities, of certain things happening. These are critical summaries that are being presented to you and

you need to be equipped to inquire about where they are from, what they mean, and how you might use them in your decisions.”

Transferring this knowledge of statistics, this model of understanding—the story underlying all numbers and data—requires a narrative that audiences can relate to. And while it takes practice and hard work to find the right story, there’s no secret to storytelling, no unique power that some have and others don’t. “We all have the basic human skill of telling each other stories,” says Timandra Harkness. “Obviously you can work on that and practice it, but it is a very basic human skill.”

Looked at in this way, the idea that scientists generally—or statisticians specifically—need to “learn” to tell stories is a bizarre thing to say. Telling stories is something we all do, at least some of the time. But we can make an effort to get better at it.

Of course, some already excel at storytelling. “Most often it’s applied statisticians or data scientists that work in a particular application area,” says Regina Nuzzo, who is now senior advisor for statistics communication and media innovation at the American Statistical Association. “That’s because they’re particularly skilled – whether by natural gift, or trial-and-error with clients – at turning their mess of numbers and information into something relevant and usable to other people. They’re not necessarily bringing a lot of emotion and dramatic arc into their stats consulting, but that’s OK. They understand the idea of a data story having a beginning, middle, and end and for it to make sense to an audience.”

We should not be too surprised by this. “Statisticians are really, almost by nature, translators and communicators,” says Harkness. “Almost a key part of a statistician’s job is to translate between the world of numbers and the world of human beings, and stories are just a brilliant way of translating anything to other human beings because we enjoy them and pay attention to them and remember them.”

So, remember this, if nothing else: Numbers do not speak for themselves. It is up to us to tell their stories.

## Action Points

- **Storytelling takes practice:** Set up a blog, a YouTube channel, or some other outlet to try different ideas, formats, and structures and styles of writing/communicating.
- **Keep your audience in mind:** People of different backgrounds, ages, and experience require different approaches. Figure out who you want to communicate with, and pitch your story accordingly. *Wired*’s 5 Levels series of YouTube videos, in which experts explain one idea to various different audiences, is a great demonstration of this: <http://bit.ly/2FKiBMe>
- **Learn from others:** If a writer or communicator inspires you, take a close look at what they do and try to learn from them. Try to adapt their storytelling structures to your own work.

- **Ask for feedback:** A story only works if it works for the intended audience. So, make sure to ask your audience for comment and criticism, and refine your approach accordingly.

## References

- Abel, J. (n.d.). Grab your audience’s attention with the XY Story Formula. Retrieved October 9, 2019, from <https://jessicaabel.com/xy-story-formula/>.
- Andrews, R. J. (2019). *Info we trust: How to inspire the world with data*. Hoboken, NJ: John Wiley & Sons.
- Bedford, H. (2019) Measles: How a preventable disease returned from the past. *BBC News*. Retrieved October 9, 2019, from <https://www.bbc.co.uk/news/health-47800438>.
- Bignell, B. (2011) 42: The answer to life, the universe and everything. *The Independent*. Retrieved from October 9, 2019, <https://www.independent.co.uk/life-style/history/42-the-answer-to-life-the-universe-and-everything-2205734.html>.
- Craven McGinty, J. (2016). Be my financially compatible valentine. *The Wall Street Journal*. Retrieved October 9, 2019, from <https://www.wsj.com/articles/be-my-financially-compatible-valentine-1455286835>.
- Davis, B. D. (2000). The scientist’s world. *Microbiology and Molecular Biology Reviews*, 64(1), 1–12. <https://doi.org/10.1128/membr.64.1.1-12.2000>
- Denning, S. (2011) Why leadership storytelling is important. *Forbes*. Retrieved October 9, 2019, from <https://www.forbes.com/sites/stevedenning/2011/06/08/why-leadership-storytelling-is-important/#529d3053780f>.
- Dokko, J., Li, G., & Hayes, J. (2015). *Credit scores and committed relationships. Finance and economics discussion series 2015-081*. Washington, DC: Board of Governors of the Federal Reserve System. <https://doi.org/10.17016/FEDS.2015.081>
- Gallup (2019) Wellcome global monitor – First wave findings. Retrieved October 9, 2019, from <https://wellcome.ac.uk/sites/default/files/wellcome-global-monitor-2018.pdf>.
- Gill, P. (2011). *42: Douglas Adams’ amazingly accurate answer to life, the universe and everything*. London: Beautiful Books.
- Hotez, P. (2019). America and Europe’s new normal: The return of vaccine-preventable diseases. *Pediatric Research*, 85, 912–914.
- Lewis, M. (2016). *The Undoing Project: A friendship that changed the world*. London: Allen Lane.
- Office for National Statistics (2019) *Labour market overview, UK*. Retrieved October 9, 2019, from <https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/bulletins/uklabourmarket/june2019>.
- Schlosser, E. (2013). *Command and control*. London: Penguin.
- Spencer, A., & Oppermann, K. (2019). Narrative genres of Brexit: The leave campaign and the success of romance. *Journal of European Public Policy*. <https://doi.org/10.1080/13501763.2019.1662828>
- Stephenson, P. (2016) How to win a referendum. *Politico*. Retrieved October 9, 2019, from <https://www.politico.eu/article/how-to-win-a-referendum-brexit-inside-story-vote-leave-campaign/>.
- Tarran, B. (2019). News. *Significance*, 16(5), 4–5.
- Yorke, J. (2014). *Into the woods: How stories work and why we tell them*. London: Penguin.



# The Power of Narrative in the Quest for Diversity and Inclusion



**Brian A. Millen**

**Abstract** Narrative is a necessary and powerful leadership tool for those working to advance equity and inclusion in our profession. While statisticians will always have an affinity and reliance on data, I submit that “Data *or* Narrative” is a false choice. The two can and must be employed together throughout the transformation process.

## Introduction

I’ve learned over time that driving real change and growth in issues of diversity and inclusion (D&I) requires speaking to both the head and the heart. Being able to share stories is a key part of this. While we should never accept or endorse anecdote as replacement for data, we should not underestimate the power of narrative: **Narrative is the supreme supplement to data.** As such, storytelling is an essential competency for all leaders interested in driving diversity and inclusion in our places of work and, more broadly, our profession.

The figure below illustrates the basic steps of a transformation effort: create awareness, call to action, execution, and measurement of progress. This is a cyclical process. Progress measures lead to new or updated awareness, call to action, execution, and additional measurement.

---

B. A. Millen (✉)

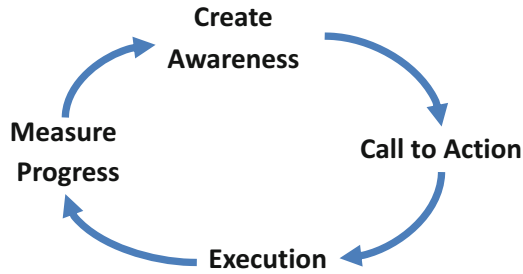
Lilly Corporate Center, Eli Lilly and Company, Indianapolis, IN, USA

e-mail: [bmillen@lilly.com](mailto:bmillen@lilly.com)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_21](https://doi.org/10.1007/978-3-030-60060-0_21)



The use of data is critical to the transformation process. Similarly, the use of narrative is critical. In the subsequent sections, I present a case for narrative in creating awareness, giving the call to action, executing the transformation plan, and measuring progress of the D&I transformation. I weave personal stories throughout as supportive examples. Hopefully, each story provides salient points helpful for leaders who will help shape the future of our profession. Moreover, I hope that each reader embraces the value of narrative and commits to telling her/his stories in support of a D&I transformation.

## Creating Awareness

Creating awareness of the need for change may be thought of as **helping people see in a new way**. Importantly, it is about helping people recognize and embrace the need for change. The required change(s) may be internal (i.e., change in the individual), external (i.e., change in others or in systems), or both. Data are critically important in creating awareness. Indeed, when it comes to issues of diversity and inclusion, research and data supporting the need for change abound. While these data are often effective at prompting an internal desire for change, their impact is multiplied when supplemented with narrative. Personal stories provide direct emotional connections that data and research statistics don't.

I have found that personal vulnerability in storytelling is helpful in facilitating trust and personal connection. In particular, sharing personal experiences of new awareness or awakening helps open others to self-examination, which is an important step in **seeing in a new way**.

In college, I had a role in campus housing which was all about D&I. Through educational programming and direct engagement (e.g., counseling, conflict resolution, etc.), I was to promote racial harmony within the campus housing community and help ensure the success of resident students of color. In this role, I proactively built relationships with all the residents of color, as well as with all campus housing student leaders (e.g., Resident Assistants, etc.). At the time, I was convinced I was among the most enlightened on the planet when it came to understanding issues of equity, diversity, and inclusion.

It was the beginning of my tenure in the role, and I was preparing for a "kick-off" meeting of sorts. As I met and spent time with residents, I would invite them to this event. In one case, I was visiting with a resident who used a wheelchair. As we wrapped up from our

conversation and laughs, I reminded him of my upcoming meeting/program and asked him to try to attend. He read the flyer and asked me a simple question regarding the venue: “Is it accessible?” I thought about it a moment. I had only been at the location of the meeting a couple times before. Each time, I had taken the stairs. But, I reasoned to myself, this was the 1990’s. We were well beyond ADA (ADA, 1990). Surely, on this major university campus, there was no building that was inaccessible. I responded, “I have only used the stairs there, but I’m sure it is [accessible].” He told me he wasn’t sure. To that, I responded that I would definitely check.

It turns out that the meeting location was not wheelchair accessible. When I learned this, I was shocked – both by the fact that the building was not accessible and by my lack of awareness!

How had I not seen this? Quite simply, because the lack of accessibility had not impacted me. I had gone to prior meetings there without issue or concern. Not seeing it was easy – even for me, the guy who always thought of others, the guy who was so sensitive to issues of equity.

For me, this story illustrates a few salient points, which efforts to create awareness must leverage:

1. **Each of us is on a journey and can grow in understanding of issues of diversity, equity, and inclusion.** Despite my work, study, and passion for creating an equitable and inclusive environment, I had room to grow.

Understanding this point enables leaders to embrace a mindset of meeting each person where she/he is and helping to accelerate her/his growth.

2. **It is easy to not see things that don’t directly impact you.** I was unaware of the building’s lack of accessibility, because it didn’t impact my ability to fully participate in campus life. In contrast, the accessibility of the building was the first thought of my friend, as signaled by his first question, as it would directly impact his ability to participate.

Understanding this point enables leaders to communicate with empathy as they create awareness. It enables leaders to adopt a mindset of creating ‘line of sight’ for others, rather than a mindset of ‘educating the ignorant.’

3. **It is often through direct relationship that we gain understanding and are impacted and, therefore, learn to see in a new way.** When I learned that the location was not accessible, it impacted me profoundly. Why? Because I was confronted with an injustice that my friend had to endure. It was because of our relationship the inequity in access had a significant impact on me.

It is with an understanding of this point that organizational D&I awareness efforts often embrace storytelling that leverages the experiences and relational connections between colleagues. When we encourage colleagues to share their stories, we open the possibilities of helping us all see in a new way. We enable awareness at a level that is not possible purely from data or statistics. Notably, unless prompted through an organized campaign, these stories aren’t often shared. Leaders hoping to create inclusive cultures must not only learn

to tell their stories but also should create opportunities for others to share their stories, as well.

A personal story, told by someone trusted and respected, can be transformational in creating receptivity to seeing in a new way.

## Call to Action

The next key step in the journey to improve diversity and inclusion is the Call to Action. Here, leaders must cast a clear vision for the desired changes and the path to get there. Simply put, the leader must clearly specify the destination and provide the roadmap to get there. In my opinion, this is where many D&I initiatives fall short. Awareness without a clear, specific call to action results in an unsustainable state of emotions for the individual and misdirected energy (at best) or chaos (at worst) for an organization.

My friend was on faculty at a school which failed to deliver a clear call to action. Noting significant differences in achievement and growth for black boys versus other students in the school, Natalie [not her real name], the school's Principal, brought the faculty leaders together to address this issue. She did a great job in creating awareness of the problem through data. The disparity was clear, and the faculty leaders embraced the need to act to create change. Although there was clear alignment among the faculty leaders on the need to act, Natalie never clearly specified the destination – for example, improving the achievement of black boys by XX, as measured by YY, in ZZ timeframe – and never provided clarity to the team on how they would get there. In short, she failed to deliver a clear call to action. As time passed, given the clarity of the need and 'fierce urgency of now,' multiple faculty leaders chose to act in a 'grassroots' fashion. As you might imagine, they did so in different ways.

Three fundamentally different approaches emerged. Some faculty leaders sought to improve the achievement of all students, reasoning that the actions would also impact the black boys. The action plan supplemented the normal education means with after-school programs where students could get additional support. Other faculty leaders reasoned that the disparity evident in the data suggested that the boys had potentially unique needs that were not being met, and they developed action plans accordingly. To supplement the curriculum, they brought in teaching materials that were more culturally relevant to black boys, among other things. Yet another group of faculty leaders interpreted the data as further evidence that the current system of education fails to meet the needs of black boys and sought to work outside the system. They chose to connect students to an Afrocentric program in the city to counter the many omissions and disservices of the school and its curriculum. The multiple efforts each had only marginal impact on students' performance. Arguably, impact from any one of these approaches could have been greater if done as part of a larger, targeted effort. The lack of a unifying call to action effectively diluted the high energy generated by creating awareness of the problem. Overall, students and families experienced the disparate actions and approaches as chaotic. They doubted that the school leaders had a clear sense of direction, questioned their commitment to the issue, and

disengaged. What began with appropriate intent and successful awareness creation ended with trust erosion and lack of positive change. This was all due to the failure to develop a clear action plan and deliver a clear call to action.

As with any transformation, clarity of vision and goals is critical for success. Along with the vision and call to action, leaders must communicate a reason to believe. This is particularly true in D&I where past aborted or perceived unsuccessful efforts may outnumber successful ones. Narrative can be a powerful tool here. Leaders may relay stories of other successful transformations in the current organization or similar successful D&I transformations at other organizations as they elicit the group's engagement. The stories may help give people a reason to believe, crystallize what success looks like, and highlight actions to avoid.

## **Execution**

Organizations attempting to drive change may do so by acting on one or more of the following three levers: organizational structure, organizational systems, and organizational culture. Driving change in diversity and inclusion for an organization is no exception.

A common approach to driving change in diversity and inclusion is to create roles or organizational units focused on this objective. Such approaches signal a commitment to results by hiring experts in the field and dedicating resources to bring about the desired change. Often, the created unit is then accountable for driving changes in systems or culture. In such cases, it's imperative that the organization's leadership communicates full support for the activities and foci of the unit so that it's understood by all in the organization that alignment with the D&I vision is nonnegotiable.

Organizations will often need to act on systems to drive change in diversity and inclusion. This includes changes to processes and procedures to enable results. Examples include recruiting and hiring processes, processes for evaluating and promoting talent, and processes for addressing actions that are inconsistent with the desired outcomes for the organization, among others.

Changes in organizational structure and systems are readily achievable. Changes in culture are more difficult and take longer to accomplish. However, success here is more enduring and is, importantly, robust to changes in personnel or systems. Changing culture requires clearly articulating the mission and values of the organization, connecting these with the D&I vision/objectives, and engaging each person in the organization to ensure that the vision is realized.

One important action in any organization undergoing cultural change is that of the individual challenging behaviors that are inconsistent with the stated organizational goals and values. Sharing real examples (stories) of individuals doing just that is infectious and empowering—and impactful in ensuring cultural change.

I was the leader of an important project that involved a small team of experienced, talented individuals. We had hired an external company to help with the effort, and today, was our first meeting for the combined team. It was during the initial soft start to the meeting – coffee and gathering before the official start of the agenda – that I observed what so many women leaders and leaders of color experience in the workplace: the assumption that the leader in the room is the white male. Each external colleague spent his/her time schmoozing with Dan [not his real name], the white male member of the team, offering only smiles and pleasantries to me and the other team members. (I would soon learn that the external colleagues' engagement of Dan went beyond schmoozing to their trying to influence additional work for them on the project.) After several minutes, we kicked off the formal meeting with introductions, starting with the external colleagues. Body language from them as they introduced themselves made it clear that their focus was on Dan. Next, my team and I introduced ourselves. It was at this time that Dan made the following very grand declaration as part of his introduction: "Let me make one thing abundantly clear for everyone here. Brian Millen is the leader on this project, and I serve at his pleasure. All decisions are his. He is in charge here. . . ." You could see and feel the change of postures in the room.

From his position of privilege, Dan confronted the bias on display and embraced his role in the team. He didn't rationalize the behavior of the external colleagues. He was aware, in that moment, of the bias and privilege that existed. He, further, took action in addressing and correcting the behavior, leveraging his privilege in doing so.

This story illustrates the impact possible when individuals recognize their privilege and embrace the responsibility to use it to drive change.

Indeed, embracing the responsibility inherent in one's privilege is part of the natural continuum resulting from creating awareness and giving the call to action. *Seeing in a new way* involves not just awareness of the experiences of others; it requires direct acknowledgment of your own experiences and how they differ. This means recognizing your privilege—in whatever form it exists. Simply put, if it is possible for you to exist and succeed *and* remain unaware of barriers for others, you have privilege. Of course, there are many forms of privilege. The story I shared from my college days highlighted my physically abled privilege. In 1988, Peggy McIntosh coined the terms *white privilege* (McIntosh, 1988) and *male privilege* (McIntosh, 1988), two commonly recognized forms of privilege about which much has been written (Bertrand & Mullainathan, 2004; Collins, 2018; Gerderman, 2017; McIntosh, 1989; Wilson, 2019; Ziv, 2019). The list continues (Case, 2017; Chugh, 2018).

When those in privilege embrace the responsibility inherent in that privilege—neither of which they asked for!—they become powerful partners and advocates for change (Chugh, 2018). It is for this reason that ally groups are increasingly sought as part of D&I initiatives—the inherent power of advocacy out of one's privilege.

The implications of this are enormous! Imagine the changes possible when people from white and other privileged communities play a role in addressing the documented racial biases that exist in policing. Imagine the progress possible when straight men and women play a role in addressing the injustices and biases that the LGBTQ community endures. Imagine the impact possible when those without physical challenges advocate for those with physical disabilities. In my college example, I never held another meeting at a location that was inaccessible. However,

I could have done more. I could have rallied all my colleagues to take the same stance. I could have pushed for a system change, such as having our management remove nonaccessible meeting spaces as options for our work altogether. This is all possible by embracing privilege and advocating for change.

When those in privilege embrace the inherent responsibility of their privilege, they become powerful allies and advocates for change.

There are countless examples everyday of individuals acting as allies to drive cultural change. I encourage each of us leading change in D&I to seek out those stories and share them. They are powerful and infectious. Each time I've shared the story of Dan's advocacy, it is met with praise. Moreover, individuals reflect on their opportunities to act in a similar fashion. In that moment, Dan becomes a role model, empowering others to embrace their responsibility to advocate for change. The power of advocacy is unleashed by telling the story.

I encourage each of us to become a main or supporting character in stories not yet witnessed or told, knowing that our advocacy will impact change. The impact will be amplified through the telling of these stories.

## Measuring Progress

Measuring progress is the final step in the (cyclical) transformation process. On the journey of creating a diverse and inclusive organization, I encourage leaders to measure progress in achieving desired *outcomes* as well as progress in achieving desired *actions* to enable the outcomes. Remaining accountable to achieving desired outcomes is critically important. Measuring progress in achieving desired actions is also important, as it can be a leading indicator of future outcomes. Additionally, sustained progress in achieving desired actions may provide evidence of cultural change, which represents the *holy grail* in any D&I transformation.

Data measuring progress are important to collect, evaluate, and share. In addition, it is important to share individual stories that amplify successes, refocus on "what good looks like" in everyday practice, and encourage additional progress.

A few years ago, I became leader of a large group. Early in that role, I saw what I thought were missed opportunities for one of the leaders who reported to me. He was being excluded from some key meetings where I was confident his contributions would add significant value. The exclusion was not accidental. Others didn't anticipate the added value from his inclusion that I did. I intervened and made the case for his inclusion. As a result, he was invited to the meetings, although with some hesitation. I openly shared with the leader on my team all that occurred to gain his inclusion. I wanted him to understand the full confidence I had in him and embrace the opportunity. Fast forward less than one year, the

situation was 180 degrees different: the group that had previously excluded him would now not make a move – even a slight one – without his inclusion, insight, and perspective!

This story illustrates the power of inclusion. The choices of individuals in leadership had the power to either squelch or amplify this person’s influence and impact. The lever for this was simply inclusion or lack thereof. It is the role of leaders to remove barriers and maximize the impact of talent in the organization. This is what is at the core of D&I transformations—dismantling the barriers that limit people’s contributions and impact. The payoff from this investment is clear.

As this next story illustrates, when delivered by a trusted leader, stories may be as impactful—if not more—than the data results which are shared.

I serve on a school board, and, periodically, the board reviews summaries of student performance on standardized tests. This is just one data element we look at, but a very important one, nonetheless. A couple years ago, the data were shared, and it was all quite impressive. There was year-over-year improvement, and, overall, achievement was high. The discussion would have normally focused solely on the data. However, in that moment, I shared a story that aligned with the data but connected in a way the data couldn’t. I shared the story of a child who had experienced significant trauma in his life, the impact of which was so great that the child never spoke while at school (perhaps, not at all). He had a support person join him in class each day. I was able to witness this child’s journey as I spent significant time at the school. I watched as the teachers, with grace, included the child in all lessons and ‘circle time.’ They modeled acceptance such that the other boys and girls in the class followed suit. There could be no doubt that the child was supported. The teachers cared so much that they held prayer sessions together focused solely on this child. With patience, each day, they included and supported the child in every lesson. For a significant period of time, there seemed to be no progress – at least in the child’s being able to verbally engage in class. To myself, I questioned if the teachers would be able to meet the child’s needs. Fortunately, the teachers persisted. And soon I witnessed a 180-degree transformation! The child was fully participating in class, visibly happy, and engaged. The child experienced such love and acceptance and growth in class that he could not stop crying on the last day of the school year. The thought of leaving – even for the summer – was devastating to him. As I shared this story – just one story behind the numbers we reviewed – the miracles taking place at the school became more evident to the board and school leaders. I, like other board members, don’t remember the details of the data presented at the meeting. We each knew it was positive, and we were appreciative of that. Every board member, however, remembers the story of this child! The story, along with the data, energized teachers, leaders, and board members to continue the work of transforming lives – that most noble call to action.

## Summary

For those interested in driving D&I transformations, it is our responsibility to help others see the need for change; cast a vision of the future; communicate an action plan to achieve the vision; enable execution; and measure progress. Narrative is a necessary and powerful tool on this journey. It is the supreme supplement to data. While statisticians will always have an affinity for and reliance on data, I submit that “Data *or* Narrative” is a false choice. The two can and must be employed together in the quest for a more diverse, equitable, and inclusive profession.



Each of us has a story to tell, and we can use our voices to accelerate the D&I transformation for our profession. I offer the following suggestions for the use of storytelling during the transformation process:

- *Creating Awareness*  
Use stories to open others to personal reflection and create receptivity to the need for personal change.  
Use stories to help establish context and clarify the problem to address or the opportunity to seize.
- *Call to Action*  
Use stories to communicate the importance of aligned action to address the problem.  
Use stories to help cast a clear vision and specify the goal or destination.  
Use stories to help communicate the reason to believe in the action plan.
- *Execution*  
Use stories to highlight individual actions that should be replicated.  
Use stories to point to successes thus far and provide means to celebrate (and believe) while on the journey. The stories can energize the team, while the destination still seems far away.
- *Measure Results*  
Use stories to amplify success (or other learnings) demonstrated in the data and establish new context, enabling the next phase of the transformation cycle.

Effective stories are relatable, memorable, and provide emotional connection.

Stories that are relatable and memorable and provide emotional connection are highly effective in supporting transformation. I encourage each person who is committed to accelerating diversity and inclusion to use her/his voice to tell her/his stories. Coupled together, data and narrative provide all we need to move hearts and minds to drive the change we seek.

Our successes will be evident in our data and our stories.

## References

- ADA. (1990). Americans with Disabilities Act of 1990, Pub. L. No. 101-336, 104 Stat. 328.
- Bertrand, M., & Mullainathan, S. (2004). Are Emily and Greg more employable than Lakisha and Jamal? A field experiment on labor market discrimination. *The American Economic Review*, 94(4), 991–1013.
- Case, K. (2017, July 21). Learning about privilege: Shattering myths of education and embracing growth. *Psychology Today*. Retrieved February 9, 2020, from <https://www.psychologytoday.com/us/blog/sound-science-sound-policy/201707/learning-about-privilege>.

- Chugh, D. (2018, September 18). Use your everyday privilege to help others. *Harvard Business Review*. Retrieved February 9, 2020, from <https://hbr.org/2018/09/use-your-everyday-privilege-to-help-others>.
- Collins, C. (2018). What is white privilege really? Recognizing white privilege begins with truly understanding the term itself. *Teaching Tolerance*, 60, Fall-2018.
- Gerderman, D. (2017). Minorities who 'Whiten' job resumes get more interviews. *Harvard Business School Working Knowledge*. Retrieved February 9, 2020, from <https://hbswk.hbs.edu/item/minorities-who-whiten-job-resumes-get-more-interviews>
- McIntosh, P. (1988). *White privilege and male privilege: A personal account of coming to see correspondences through work in women's studies*. Wellesley: Center for Research on Women. Working paper 189. Print.
- McIntosh, P. (1989, July/August) White privilege: Unpacking the invisible knapsack (pp. 10–12). *Peace and Freedom Magazine*. A publication of the Women's International League for Peace and Freedom, Philadelphia, PA. Retrieved March 16, 2017, from <https://nationalseedproject.org/white-privilege-unpacking-the-invisible-knapsack>.
- Wilson, C. (2019, April 2). Just how bad is the gender paygap? Brutal when you look at a lifetime of work. *Time*. Retrieved February 9, 2020, from <https://time.com/5562269/equal-pay-day-women-men-lifetime-wages/>.
- Ziv, S. (2019, July 11). 3 Ways the gender pay gap is even bigger than you think. *Forbes*. Retrieved February 9, 2020, from <https://www.forbes.com/sites/shaharziv/2019/07/11/gender-pay-gap-bigger-than-you-thnk/#4ff6743f7d8a>.

**Part VIII**  
**Life Telling**

# The Coin That Improbably Landed on Its Edge



Ksenija Dumičić

**Abstract** My inclusive leadership roles as a female statistician are described. I have enjoyed helping people to gain more, whether at the university through leading my department, study programmes, or projects; at the national association by leading conferences or editorial boards; and in business by establishing a respected market research agency operating internationally.

## Introduction

This chapter presents my experience as a female academic leader, following an inclusive approach in different statistical organizations and guiding many of my colleagues and students. After the introduction and my brief curriculum vitae, I describe the formal and informal leadership roles I have held during my professional career as a statistician, starting from my experience at the university through leading different statistical groups, such as department, study programme, project, association, section, conference, editorial board, etc., and establishing a respected market research agency on the national, regional, and international levels.

Many common features of inclusive leadership, whether practised by a woman or man, might be considered, but I focus on those relevant to influencing others to achieve their full potential and to helping them discover new, positive ways to develop their professional careers and their personal lives. While leaders of both genders may pursue this approach, practice has shown that women must often be more skilful and dedicated to this goal because of differing societal expectations. To be a female leader in the statistics profession is challenging and carries a large responsibility. Following guidance from my own mentors and my personal experience, this chapter concludes with recommendations to improve the

---

K. Dumičić (✉)

University of Zagreb Faculty of Economics & Business, Zagreb, Croatia

e-mail: [kdumicic@net.efzg.hr](mailto:kdumicic@net.efzg.hr)

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_22](https://doi.org/10.1007/978-3-030-60060-0_22)

practical measures to reach common goals with collaborators, fostering the feeling of inclusiveness that “we all own what we achieved.”

## The Invitation

When I was invited to contribute to this action-oriented book on leadership in statistics and data science, with the emphasis on inclusiveness, I was not quite sure how to proceed. In addressing *how* to be an inclusive leader, the editor suggested that I include in the content the inclusive and humanistic leadership issues to show that women may make a real difference in statistics workplaces and beyond, focusing on how to create inclusive organizations. From my perspective, I also questioned whether I had actually worked in a “top” position. However, the editor convinced me that many of my leadership achievements, such as my role in establishing one of the leading market research agencies in the Balkans or chairing Croatia’s newly established statistical association (now a voice in statistics not only at the national level, but also internationally), would benefit and embolden readers. After such encouragement, I decided to share some of my experiences.

As a disclaimer, I consider myself an unintentional leader, as defined by Ash (2016). My successes have been primarily a consequence of hard and dedicated work, and in many cases, I have put my own interests aside and worked towards some higher goal, which I considered worthy.

While thinking about this chapter, I chatted with a friend who has little experience in statistics or leadership, and she observed, “To be an inclusive leader might be pretty similar to undertaking a gene promoter role in genetics.” Researching her reference online, I found a definition of “gene promoter” that includes “. . . help unblocking (some) potential and enable (some) activity . . .” (Walhout, 2011). In a Medical Dictionary (2019), “gene promoter” was redirected to “promoter,” which is explained as, “One that promotes, especially an active supporter or advocate.” Finally, Collins Thesaurus of the English Language (2002) informs us that “promoter” can mean as follows: “organizer, arranger, entrepreneur, impresario; and . . . supporter, champion, advocate, campaigner, helper, proponent, stalwart, mainstay, upholder.” In addition, Gagniuc and Ionescu-Tirgoviste (2012) catalogue ten types of gene promoters. Altogether, “supporter” and its synonyms point to promoter as a person or thing that encourages progress or success of (somebody or something). The perspective intrigued me and piqued my interest in this topic even more.

Later, still considering this challenging invitation, I talked to a colleague, an expert in sports statistics, who offered, “Inclusive leadership? How thought-provoking it seems to be!” He reminded me that leaders and followers could be compared to a thermostat and a thermometer: the thermostat or leader is a regulator of temperature, while the thermometer or follower measures the temperature being regulated by the thermostat. Following this avenue of thought further, I found a simple, but clear explanation from Barger (2015) on one lesson on leadership: if

it gets too cold, the thermostat adjusts, warming it up; if it is too warm in the room, the thermostat adjusts cooling it down. The action depends on the goal—the temperature—that has been set. Of course, many leaders, teams, or other stakeholders get fixed in the role of thermometer. In other words, if it is cold and an individual, team, or organization is lifeless in a given situation, everyone runs cold. Alternatively, if it is warm with significant tension, everyone runs warm. In this environment, actions and results depend on the immediate temperature and the level of internal tensions.

In this sense, leaders can work with their colleagues in the “thermostat mode” and dictate exactly what temperature should be targeted to achieve the optimal results. If they want to be inclusive leaders, they are inclined to achieve warm atmosphere in collaboration and to reach a joint success, with collective results. They adjust themselves and take the necessary time to ensure that all team members recognize the type of situation being targeted. They consistently and precisely communicate, and implicitly lead colleagues to understand the temperature they are struggling to reach. When it is too warm or too hot, they cool down the temperature, and when the atmosphere is too icy, they have the skills to warm it up and to “recreate” life.

I myself would say that probably the role of an inclusive leader can also be equated with the role of a midfielder in football, who for the most part is not the main goal-getter, but is crucial in their achievement by others.

With this prologue from friends not familiar with the leadership theory, I became fully inspired and encouraged to pursue this chapter. However, where to start?

First, it was necessary to understand clearly, what inclusive leadership means. As with professionals in any other vocation, statisticians should apply leadership to promote and develop their profession in areas including statistical science, literacy, reasoning, awareness, or culture. Because many other professions and activities rely on statistics heavily—facts and figures that result from statistical methods are encountered in reports or news—society and business share a common interest in raising awareness of the importance of the quality of information obtained by these methods, and statisticians must continuously improve their leadership skills, beyond how they relate narrowly to the statistical issues of leading a small working team or a project or to mentoring students. Apart from developing statistical methodologies and results on the one hand, we also promote a more appropriate and useful application of statistical results, contributing to higher quality of life for individuals and society in a broader sense.

## **Curriculum Vitae in Brief**

### ***. . . Education, Employment, Field of Research, and Mentoring in Statistics***

Regarding my education, at the University of Zagreb Faculty of Economics & Business (FEB) in Croatia, in 1979, I gained my Master Degree in Marketing, and in

1992, my Ph.D. Degree in Social Sciences, Humanities, and Theology, in the Field of Economics, also completing a postgraduate study programme in Quantitative Methods for Economic Analysis. My first workplace was in marketing research within the Development and Research Center of the company “Josip Kras,” one of the largest producers of chocolates, sweets, and cookies in Yugoslavia. I have been employed at FEB since 1981 continuously and became a tenured Full Professor in 2010. I was Head of the Department of Statistics from 2006 to 2010. Since 2007, I have been the leader of statistical postgraduate studies at FEB, the first such programme in Croatia.

I attended the “Public Opinion Polling” session provided by Professor Allan L. McCutcheon (1950–2016), an expert from the Gallup Research Center, from the University of Nebraska-Lincoln in the USA, held in the Center for Applied Statistics at the Central European University in Budapest, Hungary. With a Leslie Kish Fellowship award, I participated in the “Sampling Program for Survey Statisticians” at the Summer Institute in Social Research Techniques, Institute for Social Research of the University of Michigan, in the USA. Next, I completed the “Sampling Techniques and Practice” course through the Training of European Statisticians (TES) Institute at the Social Statistics Research Centre of the University of Southampton, in the UK. These outstanding opportunities charted my path and developed me into a survey sampling statistician primarily.

In my research, I am focused on survey sampling, statistical research methods, statistical quality control, business statistics, multivariate methods, and statistical education. I especially focus on statistical literacy issues, and the role and position of youngsters and women in statistics, promoting statistics at all levels. Being a strong proponent of continuous learning, I regularly meet with statisticians and attend lectures and webinars on the mentioned and similar topics, as well as give invited lectures myself. These activities make me feel connected to the statistics community and the audience that is interested in the statistical issues and concerns.

Teaching at all education levels, up to the doctoral level at FEB and universities in Bosnia and Herzegovina, Slovenia, and North Macedonia, I mentored and advised ten Ph.D. students and supervised many bachelor, master, and postgraduate students. Many of them secured high positions among statistical analysts in respective departments and organizations in Croatia and abroad, got many University awards and other important recognitions, of which I am very proud, enjoying that I used the opportunity to participate and help them grow.

### ***... Starting the Croatian Statistical Association, Its Special Interest Group, Journal, and Conference***

In 2015, I helped to start the Croatian Statistical Association (CSA), served as its first active President, and helped to create its scientific journal, *Croatian Review of Economic, Business and Social Statistics* (CREBSS), becoming its first Editor-in-Chief (Photo 1).



**Photo 1** Ksenija Dumičić (second from left), Croatian Statistical Association President, at the 2017 Applied Statistics Conference in Bled, with statisticians from North Macedonia and Slovenia

Within the CSA, I enabled this journal to gain significant scientific indexation in a short period of time. In 2016, I initiated the start of the International Statistical Conference in Croatia (ISCCRO), which has since been organized every second year (Photo 2).

Between 2015 and 2019, as the CSA's President, I was the Council member at the Federation of European National Statistical Societies (FENStatS) and a Board member at the European Courses on Advanced Statistics (ECAS). In 2018, I founded, and have since been chairing, the CSA's special interest group, "Section on Women in Statistics."

### *... Membership and Honours in Statistics*

As an Elected Member of the International Statistical Institute (ISI), I am also a member of its International Association for Survey Statisticians (IASS), International Association for Statistical Education (IASE), and the ISI special interest group "Committee on Women in Statistics" (CW-ISI), where I have represented Europe on its Management Committee since 2017. I am a Royal Statistical Society (RSS) Fellow, a Regular Fellow of the American Statistical Association (ASA), and a Fellow of the American Society for Quality (ASQ), where I participate in its



**Photo 2** Ksenija Dumičić, with Amanda Golbeck at the first International Statistical Conference in Croatia in 2016 in Zagreb



Statistics Division. Recently, I also joined the Caucus for Women in Statistics, an independent organization.

Springer's *Encyclopaedia of Statistical Science* (2011), published in three volumes and written on 1850 pages, has a total of 636 entries authored by more than 600 scientists from about 500 institutions in nearly 100 countries covering 90% of the world's population within all continents. Authors are professors of statistics and related disciplines in the fields of natural, social, humanistic, technical, and biomedical sciences, theoretical and applied statistics, demography, etc., and scientists dealing with operations research, official statistics, and statistical quality control. While I was Croatia's Editorial Board member, Croatia contributed the largest number of entries per country compared to other countries.

It was interesting that three of us, Professor Miodrag Lovric (2011; Editor-in-Chief), from Serbia, Editorial Board members Professor Jasmin Komic, from Bosnia and Herzegovina, and me from Croatia, all being the Encyclopaedia's Organizing Committee Presidents for our respective Ex-Yugoslav countries involved in War during the 1990s, were Nobel Peace Prize Nominees for 2011 (Symanzik & Vukasinovic, 2011). This nomination, which came from Japanese scientists and was supported by several Nobel Prize laureates and governments, did not seem to be very likely, but it flattered us very much. Moreover, we really enjoyed and were delighted

completing this Encyclopaedia, knowing that it promotes statistics and helps many statisticians in their work all over the World.

### ***... Founding the Statistical Research Agency Operating Internationally***

As a sampling statistician and being skilled in marketing, in 1993, I helped found the leading Croatian public opinion and market research agency, Puls Ltd., later Ipsos Croatia, operating in the West Adriatic region. My co-founders came from the fields of psychology, sociology, mathematics, informatics, and law, which enabled performing outstanding networking and achieving excellent operating results.

### ***... Projects, Publications, Editorial, and Professional Duties in Statistics***

During many years, I led and participated in a number of projects granted by the Ministry of Science in Croatia, University of Zagreb, and Croatian Science Foundation. As a sampling expert, I engaged in projects granted by the European Commission, UNICEF, World Health Organization, and UNHCR, while the World Bank contracted me in 1996 to develop a Statistical Master Plan for the Republic of Croatia.

I have more than 220 publications, 80 scientific journal articles, approximately 80 conference proceedings papers, 14 books and book chapters, etc. In other occasions, I performed as the Invited and Plenary Speaker at international conferences and meetings. I am indexed in the Scopus and WoS databases. Besides being CREBSS' Editor-in-Chief, I have been an Editorial Board member for a number of international conferences and three Scopus Journals.

I have had a number of professional duties in Croatia and internationally, and I will mention two. Both are related to youngsters and helping them to grow, which has been very important to me. Since 2017, I have been a Jury Committee member and an Ambassador for Statistical Competition for the high schools in Croatia. My activities started with the project "Support for statistical literacy actions in the area of a competition, gamification, and e-learning," which was conducted by the Croatian Bureau of Statistics and funded by the European Commission. This gives me an opportunity to help increase statistical literacy and knowledge among youngsters. Since 2016, I have been an International Programme Committee member for the Young Statisticians Meeting (YSM), a programme established in 1996 to help Austrian, Croatian, Italian, Hungarian, and Slovenian young statisticians to present their research papers as invited speakers in front of a distinguished international statistical audience.

## Why a Coin Is Hardly Ever Seen Landing on Its Edge

If you toss a coin, the result is heads or tails, right? Karl Pearson, one of the most famous statisticians, contributed enormously to probability theory and promoted an empirical approach, based partly on tossing a coin repeatedly. By increasing the number of repetitions, Neyman and Pearson (1928) conducted an experiment by tossing a fair coin even more times,  $n \rightarrow \infty$ , to examine the empirical probability of how many times they should repeat the toss to prove that it would seem the coin landed on its edge. Murray and Teare (1993) examined this problem, designed a dynamic experimental model, and solved it by using numerical simulations. Results of the experiments, such as Pearson's approach, and the simulations were consistent, confirming that the model includes the necessary features of the dynamics of the tossing experiment. Extrapolations based on this model show that the probability of a US nickel landing on its edge is close to 1 in 6000. But, is this probability practically zero or not zero, and is it worth trying to experiment with it at all?

To extrapolate to my own situation, what is the probability that a young woman working in academia as a statistician without any experience in entrepreneurship in a war and post-war environment will become part of a new public opinion research agency in a transition country like Croatia where the profession is not yet recognized, an agency established by an unemployed postgraduate student from another discipline that she met during a lecture? Indeed, in 1993 the agency was modestly founded as a copy-studio, like many other companies that started from "a garage," and eventually at the very beginning of the twenty-first century became the largest and most highly regarded research agency in Croatia and later the region. Most of the models would show this probability is also very low, maybe only a little higher than a coin landing on its edge.

The chances of this series of events are even slimmer, when the environment is taken into account, especially in the early 1990s: a traditional nation, where men dominate in key positions in the society. Yet, a woman found the opportunity to lead a newly established national statistical association, as well.

Low probability—whether of a coin landing on its edge or a woman succeeding against all odds—should not deter us from trying. However low the probability, the probability when not trying is indeed zero. Knowledge, hard work, and dedication might not always be recognized immediately, but in the long run, they usually are. Besides selected colleagues and relative supporters having significant impact, luck of course can play a role in success. However, the more prepared you are, the less luck you'll need.

## Inclusive Leadership Is Natural for Women in Statistics

Leadership can be defined in many ways. Merriam-Webster's dictionary (n.d.) says leadership is leading and guiding other people. I would say this is too narrow.

Leadership is also guiding, inspiring, and empowering others to see, learn, do, and become more.

Billard (2016) emphasized that leaders appear at any level of society and always have followers, and that effective leaders are essentially those who can effect change, for good or ill, by successfully encouraging those around them and facilitating their work to support their goals and agendas. She considered three types of leadership: transformational, transactional, and laissez-faire. According to Bass (1990) and Bass (1998), transformational leadership is based on a leader's hard work and high energy. These leaders have strong personal integrity and are dedicated to a company's success ahead of personal interests and grounded in sound ethical standards and trust. They do not expect favours or personal advancement and ease the work of their followers, resulting in group inclusiveness. Transformational leadership is practised more often by women than men. The inclusive nature of transformational leadership is appropriate for academia and particularly for women in academia. Bass and Steidelmeier (1999) said the success of followers under transformational leadership is mutual success, which holds for academia, too. Pseudo-transformational leadership happens when leaders initially motivate their followers, but later give priority to their personal interests. On the other side, transactional leadership suggests a contract between leader and followers, which could be very ineffective. Billard (2016) mentions that the literature only recently began to focus on female leaders and, while investigating the position of women among academic leaders, notes that female leaders are most often in lower levels of the hierarchy, although there are some exemplary exceptions in professional associations.

According to Sugiyama, Cavanagh, van Esch, Bilimoria, and Brown (2016), inclusive leadership is leadership comprising social skills that value both the uniqueness and belonging needs of diverse identities to create business effectiveness in the long term. Prime and Salib (2014) add that belongingness plus uniqueness equals inclusion in most countries. After Alemany (2014), leadership is the human ability to enlist the aid and support of others in the accomplishment of a common task, and, looking at the greatest leaders, common characteristics could be found. Leaders, who put their own interests behind the common good as in inclusive leadership, equalize their interests to those of their followers and have a strong chance of becoming great leaders. Additionally, leaders must not be blinded by the collected power and authority, or risk turning towards harmful goals.

Rao (2016) emphasizes that statisticians are often in service to others, whether working in official statistics, industry, education, research, government agencies, ministries, media, or elsewhere and whether teaching, designing studies, or collecting and interpreting data in any sector. Since inclusive leadership is essentially serving a common goal and the inclusive feature of transformational leadership is based on dedication to the common or organizational good ahead of personal interests, statistician leaders can naturally adopt an inclusive leadership approach when collaborating with groups across various environments. Rao adds that leaders need several skills to serve this purpose, but is ambiguous on whether using

statistical skills in the service of others develops leadership skills or having leadership skills implicitly leads to more opportunities to serve.

Wasserstein (2016) follows Bob Rodriguez's idea that statistical leadership is seen everywhere and stresses that the majority of a statistician's work serves the interests and needs of others. Statistical leadership, inclusive or otherwise, can influence a wide range of important economic and social activities. These include, for example, production processes or education processes, such as collaborating, teaching, or mentoring others in any statistical project, including surveys, preparing presentations of results, informing business decisions, and analysing and interpreting results. Leadership also contributes to improving statistical literacy, reasoning, and awareness generally, which can improve the well-being, health, and overall knowledge of the citizenship, improving the statistical skills in targeted audiences, particularly the media, financial, and other services and goods that rely on numerical literacy. In the modern, digitized global economy, connecting data scientists, who have high technical skills, with policymakers who have more traditional business and analytical skills might benefit from inclusive statistical leadership, especially since any statistician must at times be a multidiscipline expert who can ease communications among these diverse groups. In addition, since humanistic leadership relies on placing the needs of people over profit, empathy, and respect for others, and a preference towards sustainable business, humanistic leadership and inclusive leadership are quite similar.

## Mentors, Followers, Collaborators

In preparing for this chapter, I uncovered many insights into leadership and, especially, into inclusive leading. I was fortunate to meet collaborators who trusted me and gave me the opportunity to lead them, even though often they were in fact leading me. As such, *I devote this chapter to my followers, reflecting on the times I did not even realize I was leading them inclusively, and especially to my own leaders, family members, teachers, mentors, and even students who shared with me this journey through a rich career as a statistician.* If I have been successful, it is because most of my collaborators succeeded in developing their own potential and reaching some of their own personal goals when pushed by my leading implicitly.

Especially, I want to point out proven inclusive leaders and mentors who I have followed in my career. Among more than a hundred teachers of mine, who I encountered during my education and later in my career, more than a dozen showed themselves to be outstanding inclusive leaders. They offered with trust and hidden anaesthesia a variety of complex lessons, pulling the best out of me. Reviewing inclusive leadership issues reminded me of one of the greatest survey sampling statisticians and methodologists ever, Professor Leslie Kish (1910–2000), who can also be considered one of the greatest inclusive leaders among statisticians, comparable to Heeringa and Kalton (2003) who taught and designed surveys around the world. Among his achievements, Kish established the summer Sampling

Program for Foreign Statisticians in 1961. Later, he founded the Summer Institute in Social Research Techniques at University of Michigan-Ann Arbor in the United States. Kish taught in many countries, illustrating that inclusive leadership has no limits and no boundaries. Many of the statisticians who completed the Sampling Program for Survey Statisticians came from developing countries and received a fellowship from the Leslie Kish International Fellows Fund. Many reached high professional levels and held powerful positions in their home countries' statistical, official, or private agencies, as well as in universities. As Kish was an excellent example of an inclusive leader, he is still influencing statisticians today through his sampling programme and fellowships. In 1997, the American Statistical Association gave Kish the Samuel Wilks Memorial Award (1997), and his citation supported the fact that Kish was an inclusive leader:

For being a truly outstanding statistician, who has had a profound influence on sample survey practice throughout the world. His originality and ability to provide practical solutions to real-world statistical problems illuminate his extensive writings; a notable example is his classic text *Survey Sampling*, which is widely consulted and referenced by practitioners of statistics everywhere. His wisdom and guidance have benefited countless colleagues and students from America and abroad. For his remarkable work as an applied statistician in consistently using his knowledge and insight for the benefit of society. At the Survey Research Center of the Institute of Social Research at the University of Michigan, he has been a leader in many areas — administration, intellectual creativity, research, training, and mentorship. His influential role in the World Fertility Survey further illustrates his impact as an international ambassador of statistics and a tireless advocate for scientific statistical methods. For being a humanitarian and true citizen of the world. His unmatched concern for those living in less fortunate circumstances and his use of the statistical profession to help is an inspiration for all statisticians.

Kish's great successors, professors James M. Lepkowski and Steven G. Heeringa, have also contributed to his legacy by spreading knowledge of survey sampling and related statistical themes, often neglecting their personal interests. I thank them both for helping me to open my potential in becoming a survey sampling statistician since 2002, when I was granted a Leslie Kish Fellowship to attend the Summer Institute in Survey Research Techniques at the University of Michigan, which they had been leading.

Other mentors, great inclusive leaders in their own right, also influenced my career and development. For one, my Ph.D. mentor, Professor Miladin G. Kovačević, currently Director General of the Statistical Bureau of the Republic of Serbia, believed in me from our first correspondence and increased my self-confidence as I prepared my doctoral dissertation and published related papers. His trust gave me the strength to follow my ideas and develop not only my statistical skills, but also my personal skills. He was an example of pure inclusive leadership. Interestingly, because of the 1990s war in the Balkans, I had to defend my dissertation without my mentor, who lived in Belgrade, and instead enlisted the support of appropriate professors in Croatia. However, my mentor's approach to teaching and statistical work made a deep impression and left a noticeable mark throughout my career.

In Golbeck (2016, 32), after considering the case of Elizabeth L. Scott, four leadership principles are especially recommended for statistical leadership. Under

the first, leadership is based on influence rather than position, even though statistical leadership, as a natural leadership practice, might be connected to organization leadership. In the second one, leadership competencies determine leadership effectiveness, leading to the recommendation that statistical leaders improve their effectiveness by developing their leadership competencies more specifically. The third emphasizes that leaders inspire teams to action towards a new vision through fascinating stories. In this sense, statistical leaders should develop evidence-based stories around statistics to motivate movement towards this vision. Finally, the fourth principle describes successful leaders as builders of relationships and recommends that statistical leaders share their knowledge as a way of influencing. I found that Scott's application of these principles might be very useful to keep in mind when practising inclusive leading.

In science, technology, engineering, and mathematics (STEM), women are under-represented, which Stoet and Geary (2018) assert should be a concern of social sciences experts and policymakers. International research data and results from 2015 showing adult achievement in science, mathematics, and reading based on a large-scale survey, which was conducted within the Programme of International Student Achievement—PISA (OECD, 2016) based on 472,242 respondents, indicate that girls placed on par or better than boys in science in almost one-third of the countries included in the research. It also indicated that more girls seemed gifted in STEM study at a college level than people had presumed. Unexpectedly, the gender differences in terms of relative academic gifts and application to STEM degrees increased with overall improvements in gender equality at the national level. In explaining this, analysis suggests that in countries with less gender equality, the burdens faced by girls and women promote a greater commitment to a STEM career path.

Pološki Vokić, Obadić, and Sinčić Ćorić (2019) consider five groups of occurrence, i.e. manifestation and participation initiatives for women, grouped according to the level at which equality initiatives could be introduced and executed, that is, society-level, state-level, organizational-level, household-level, and individual-level initiatives. Regarding organizational-level presence initiatives for women, the Croatian academic units came together to compete in the international programme “Women in STEM award” prepared by the Deutsche Telekom. For the first prize, female graduates all over the world participate who have a final thesis on the following topics: “Artificial Intelligence,” “Internet of Things” or “Cyber Security.” Through promoting such initiatives, the authors raise the visibility of women in STEM and promote their part in society, giving the women the acknowledgement they deserve. Their chapter ends with the social, macroeconomic, and microeconomic benefits of women's presence initiatives, which enlarge the opportunities of women to lead, and to lead inclusively, especially.

## **Illustrating My Approach to Inclusive Leadership . . .**

Three stories might better illustrate my approach to inclusive leadership.

### ***. . . At a Statistical Research Agency***

Although I was employed in academia, I influenced and helped found one of the first public opinion and market research agencies in Croatia. The effort began during the war years following the break-up of Yugoslavia in the early to mid-1990s and continued into the 2000s. Working with others in the agency, I encouraged the agency to evolve from a middle-sized enterprise focused on Croatia to, eventually, a multinational concern with offices in eight countries in the Adriatic region. Part of the growth into an international company was accomplished by merging with another regional research organization.

One day in 1993, when I did not expect any extra job offer, a postgraduate student of mine from another faculty visited me at home and invited me to join his small research team at a UN organization project for Croatia as a sampling expert. It was raining heavily that day in the middle of the War in Croatia, and I could hardly imagine doing anything outside of my ordinary teaching. Of course, I wanted to help my student, so I did not even ask for compensation and did not have any expectations for future engagements. But, my student came back after eight months with the offer of a second collaborative project, and after an additional 3 months, he and his colleague appeared with a third one, and so on, until we finally decided to start the company together as partners. At the beginning, we did not have more than three personal computers, and we only sold our research reports to international non-profit organizational clients, which was compatible with the fact that in post-communist Croatia a market for our services was not developed. But after some time over several years, we expanded to include several employees and started to also cooperate with commercial clients in marketing research, rather than being limited to public opinion research only. Every few years, the agency moved from a smaller office to a bigger one, and after 15 years, we opened many workplaces and became a middle-sized enterprise, networking and operating in a wider Adriatic region, covering eight countries with many partners. The enterprise became the most developed one in the area of market and public opinion research in Croatia and wider, becoming part of a big international company.

However, I have never been either a manager or even an employee in this agency, doing only statistical sampling design consulting and coaching for my partners inclusively. My personal profits have come from fulfilling my vision of employees' professional development, agency economic security on the market, and clients' satisfaction. In this endeavour, I have applied the research code of ethics and continually improved research quality, always nurturing business transparency and confidence with the partners. Of course, without dedicated work and the same



intention of the selected collaborator partners, this agency could not have survived to reach such respectable “good for all” goals. Inclusive leadership principles were especially helpful here in influencing my colleagues to rise to the best of their capabilities and create a collaborative workplace that was not apparent at the beginning.

### ***... When Leading a Postgraduate Programme and Mentoring in Academia***

As an adjunct to my relationships with colleagues in the Department of Statistics over several decades, from 2005 to 2007 I initiated to organize and establish a postgraduate degree programme in statistics, the first of its kind in Croatia. Since then, I have been its formal leader as well. Ongoing since the first graduating class in 2007, I have worked closely with bright students pursuing the discipline of statistics. In 2019, I invited an academic colleague, who I mentored for the PhD dissertation, to co-chair the programme with me. This was a way of sharing leadership opportunities and experiences.

Inclusive leadership led me to promote this new study programme to prospective students, telling them—in an echo of Bilgin’s 2019 talk to the 63rd World Statistics Congress in Kuala Lumpur, “Statistics – A ticket to anywhere”—that statistics studies can lead anywhere (Bilgin, Bulger, & Fung, 2019). On one hand, along with my colleagues, I was dedicated to improving the teaching processes within the statistics discipline and adjusting them to meet student needs. On the other hand, my engagement with the students was not only related to teaching, service, and administrative tasks, but also related to influencing students and motivating them to enroll in the postgraduate programme. In part, this included helping them to realize the full usefulness of statistics as a great career opportunity in the modern economy, including how a statistics career could improve their quality of life and open many different perspectives for the future, as well as helping them study more efficiently. I also enjoyed working with students to define topics for their final theses, organize and execute the necessary original research, and publish articles or make presentations of their results, often at international conferences.

I was delighted to take on this demanding role and become a mentor to many of these postgraduate students, influencing them and raising their interest and enthusiasm for the profession. Some of the students who graduated from the programme have started teaching statistics informally, even though their main occupation is not in education. In this way, by sharing my passion for statistics as a calling and an occupation, almost 80% of the students who enrolled in the postgraduate programme have completed it successfully, and most of them are employed as analysts performing sophisticated analyses in the governmental macrolevel institutions or in the private sector in statistics or a related field. Many

have participated in various research projects, and some are working towards their doctorates or already earned the Ph.D. degree.

I was privileged to be helped by extraordinary mentors at various stages of my life, and as such, they served as role models in my efforts to lead students in setting and achieving their own goals. Over more than three decades of teaching, I have been privileged to mentor many undergraduate and postgraduate students. This offered me an opportunity to lead them to successfully gain knowledge in a variety of statistics topics, complete their works, theses, and presentations, and, in many cases, prepare for the life of an academic. Some of them have followed a career as a professional statistician, while others have not, but for each, the statistical methods and ideas they have learned have made a valuable contribution to their pursuits.

I consider such mentoring to be a pure form of inclusive leadership, especially when based on sharing an enthusiastic approach, motivating the university or other students to conduct original research, opening the minds, initiative, capability, and creativity of these students, and efficiently helping them to complete the seminar and their various projects. Under such mentorship, students have a vision that something good can follow statistical studies. In job applications, improved statistics skills could only give them an advantage over other job seekers. It fills me with pride, when the students I have mentored tell me how their capabilities are appreciated in the workplace.

In this context, another leadership—or perhaps life coaching—role should be mentioned. In many cases, I have had the opportunity to influence students who, for various reasons, have had little faith in themselves and were near to dropping out or following less attractive career paths. Changing their perception of statistics and themselves gave them the strength they needed to continue the programme. The fact that I was also a formal Head of a Department of Statistics did not create any boundaries for me to lead such students inclusively.

### ***... When Building a National Statistical Society***

With a feeling of great responsibility, I was honoured and delighted when I was invited in 2015 by colleagues from the Croatian Bureau of Statistics to join them to reactivate and build a national statistical association. Between 2015 and 2019, I helped found the Croatian Statistical Association (CSA), becoming its first active President. The CSA is a fast-growing national statistical society. Though one of the youngest in Europe, it had already joined the Federation of European Statistical Societies by 2017.

By 2019, the CSA had attracted almost 100 members. It had initiated the International Statistical Conference in Croatia (ISCCRO), which already attracted more than 100 presentations per conference, prepared by more than 200 authors from more than 20 countries. It had already begun publishing a scientific journal, which has been indexed by 30 scientific databases after only four years of publication.

As an important theme globally and especially for its potential to be a valuable contribution to the field, in 2018, I initiated and established and chaired the CSA's "Section on Women in Statistics." This section promotes women in statistics, science, education, and related professions, statistics about women, and information about female leaders in statistics, as well as international and national events and publications regarding women in data science and statistics.

Enthusiasm for the CSA made it a prime candidate for inclusive leadership. Inclusive leadership has brought in scores of volunteers to the programmes to work towards various goals of the CSA. In many cases, these volunteers, mostly colleagues of mine, as well as students, discovered and honed skills and talents that they didn't realize that they possessed. Several very active colleagues of mine were crucial in achieving the goal to activate the CSA. They helped to make it come alive through several concrete projects like "the international statistical journal" and "the international statistical conference," as well as "starting the CSA's special interest groups," such as CSA's "Section on Women in Statistics" and others. The CSA is currently run by a young Assistant Professor from my Department, who was my Ph.D. student and who grew in parallel with the CSA, which makes me especially proud.

## Thoughts on Helping Women Rise to Become Inclusive Leaders

My experience and research have led to a handful of ideas that could be helpful to women who wish to be inclusive leaders. These thoughts could be generally helpful in creating and effectively leading any inclusive organization, not just those focused directly on statistics:

- *Know statistics:* Be competent in your field and don't miss any opportunities to improve your statistical skills and knowledge, as well as perhaps your teaching skills if relevant. Maintain a network of other statisticians to exchange valuable experiences.
- *Know the business:* Understand underlying business activities, such as costs and benefits, understand the specifics about industry, be well-versed in your industry, and be engaged in activities such as education, official statistics standardization, and the performance of non-profit associations.
- *Promote openness:* Communicate, negotiate, and make decisions openly and effectively.
- *Appreciate diversity:* Build inclusive environments that appreciate the diversity of collaborators, valuing different identities, talents, and experiences. Promote feelings of acceptance for their talents and uniqueness.
- *Balance corporate and self:* Dedicate yourself to the goals of your company, while staying honest with yourself and never abandoning your essential principles.

- *Exhibit kindness:* Kindness opens all doors, so sharpen it.
- *Discover appropriate paths:* While executing your duties, recognize that there would be several paths that reach the same goals. Try to find a path that is aligned to your principles. Remember Brooks' (2015) admonition that quality is not what you do, but who you are, and develop ethical characteristics and an awareness of the consequences of your actions.
- *Engage:* Be active in your organization. Develop your vision and share it with your collaborators, inspiring them, initiating change, and showing your passion.
- *Look ahead:* Make plans and be focused, but at the same time stay flexible and readily adapt to new circumstances.
- *Don't only teach:* Be prepared to learn from your followers, since their creativity can sometimes lead to hidden solutions.
- *Understand collaborators:* Listen to your collaborators and strive to understand what they need, their main drivers, and their potential.
- *Celebrate success:* Understand, appreciate, reward, at least by kind and encouraging words, and recognize the successes of your collaborators when appropriate.
- *Encourage:* Help, advise, support, and teach your collaborators new skills. Mentor them, especially those less experienced.
- *Trust others:* Delegate tasks and trust your followers' capabilities. Support their abilities and creativity.
- *Appreciate others:* Respect not only followers, but other leaders, as well, and appreciate the experience of others.
- *Foster cooperation:* Include your collaborators in project phases and tasks where their unique talents can allow them to contribute enthusiastically. Use these opportunities to develop their potential and discover innovative solutions.
- *Improve yourself:* Exercise modesty. Never stop learning or improving your skills and knowledge, whether in statistics, business, or leadership. Strive for more effective results, with higher quality from less time.
- *Cheerlead:* Promote the statistics profession and inclusive excellence at every opportunity.

Inclusive leaders are those who strive to help their collaborators feel included. Such leaders are more enthusiastic and empathetic and help other team members as they work towards common goals. Inclusive leaders recognize similarities among team members, accentuating feelings of acceptance and togetherness, while at the same time acknowledging members' uniqueness. The result is an integrated team with a common purpose and a sense of shared accomplishment. Regarding money reimbursement you might expect, be aware that only a true, honest unselfishness inbuilt in your leading influence may assure you satisfaction, and even an extra money award, when you did not even ask for it primarily.

To summarize, as a woman in academia, I succeeded as the head of the university's statistics department and founded the postgraduate programme in statistics. In addition, I was the president who started a national statistical society and was the founding chair of its "Women in Statistics Section." Within this association, as its first Editor-in-Chief, I also influenced the start of Croatia's first

scientific statistical journal, which is internationally recognized and indexed by scientific databases. As president of the national statistical society, I helped to start the country's first international scientific statistical conference. By participating in the work of sections, meetings, and competitions not only for women, but also for young statisticians, I influenced how they grew and developed as well. Outside of academia, during the war circumstances in my country, I helped to create a private public opinion and market research agency, which I eventually worked to expand into a multinational agency, without ever being its formal leader or even being employed in it. By all of these activities of mine, I influenced inclusively, so that my collaborators or respective projects' participants could develop themselves to approach their full potential.

In doing all this, I applied a transformational inclusive leadership approach, influencing colleagues and partners in my environment towards common and individual goals, even though at the time I was not aware of the label "inclusive leader." I want to thank to all of my mentors and followers. I devote this chapter to them, who remain largely unnamed for fear for omitting someone.

One can be born as a leader, but I assure you that one can also grow oneself to be a leader. The inspiration and stimulation one finds in his or her mentor/s—like what I have found in my own mentors for me—is priceless. *I am grateful to all of them.*

## References

- Alemaný, J. (2014). The one thing the most admired leaders have in common. *The way of wisdom. Personal blog*. Retrieved May 20, 2019, from <https://jordialemany.wordpress.com/the-one-thing-the-most-admired-leaders-have-in-common/>.
- Ash, A. S. (2016). Lessons from an accidental leader. In A. L. Golbeck, I. Olkin, & Y. Gel (Eds.), *Leadership and women in statistics* (pp. 323–338). Boca Raton, FL: CRC Press.
- Barger, J. (2015, May 25). Thermometer vs. thermostat. *Leadership Lessons by Jason Barger. Blog*. Retrieved May 20, 2019, from: <https://jasonberger.com/author/jason-berger/>.
- Bass, B. M. (1990). From transactional to transformational leadership: Learning to share the vision. *Organizational Dynamics*, 18, 19–31. Retrieved June 10, 2019, from [https://www.mcgill.ca/engage/files/engage/transformational\\_leadership\\_bass\\_1990.pdf](https://www.mcgill.ca/engage/files/engage/transformational_leadership_bass_1990.pdf)
- Bass, B. M. (1998). The ethics of transformational leadership. In J. B. Ciulla (Ed.), *Ethics, the hearth of leadership* (pp. 169–192). Westport (CN): Praeger.
- Bass, B. M., & Steidelmeier, P. (1999). Ethics, character, and authentic transformational leadership behaviour. *Leadership Quarterly*, 10, 181–217. Retrieved June 10, 2019, from [http://kirkwarner.weebly.com/uploads/2/3/0/3/23039960/transformational\\_leadership\\_-\\_bass.pdf](http://kirkwarner.weebly.com/uploads/2/3/0/3/23039960/transformational_leadership_-_bass.pdf)
- Bilgin, A. A. B., Bulger, D., & Fung, T. (2019). Statistics is a ticket to anywhere. Invited Paper Session: IPS-147: Building future generations of statisticians through outreach. *Proceedings of the 63rd World Statistics Congress – WSC, ISI2019*, 18–23 August, 2019, Kuala Lumpur, Malaysia.
- Billard, L. (2016). What makes a leader? In A. L. Golbeck, I. Olkin, & Y. Gel (Eds.), *Leadership and women in statistics* (pp. 85–102). Boca Raton, FL: CRC Press.
- Brooks, Ch. (2015). Quality in the first person: Identity crisis. *Quality Progress*. Retrieved May 20, 2019.

- Collins, Free Online Dictionary and Thesaurus. 2nd Ed. (2002). *Promoter (a dictionary entry)*. New York, NY: HarperCollins Publishers. Retrieved May 15, 2019, from: <https://www.collinsdictionary.com/dictionary/english/promoter>
- Gagniac, P., & Ionescu-Tirgoviste, C. (2012). Eukaryotic genomes may exhibit up to 10 generic classes of gene promoters. *BMC Genomics*, 13, 512. <https://doi.org/10.1186/1471-2164-13-512>. Retrieved May 15, 2019, from <https://bmcgenomics.biomedcentral.com/track/pdf/10.1186/1471-2164-13-512>
- Golbeck, A. L. (2016). Four leadership principles for statisticians: A note on Elizabeth L. Scott. In A. L. Golbeck, I. Olkin, & Y. Gel (Eds.), *Leadership and women in statistics* (pp. 31–52). Boca Raton, FL: CRC Press.
- Lovric, M. (2011). *International encyclopedia of statistical science*. New York, NY: Springer.
- Kalton, G., & Heeringa, S. (Eds.) (2003). *Leslie Kish: Selected Papers*. Wiley Series in Survey Methodology. New York: John Wiley & Sons.
- Medical Dictionary. (2019). Gene promoter (an encyclopedia entry). Retrieved May 15, 2019, from <https://medical-dictionary.thefreedictionary.com/Gene+promoter>.
- Merriam-Webster's Dictionary. (n.d.). Leadership (a dictionary entry). Retrieved May 10, 2019, from <https://www.merriam-webster.com/dictionary/leadership>.
- Murray, D. B., & Teare, S. W. (1993). Probability of a tossed coin landing on edge. *Physical Review, E*, 48, 2547.
- Neyman, J., & Pearson, E. S. (1928). On the use and interpretation of certain test criteria for purposes of statistical inference. *Biometrika*, 20A, 175–240. <https://doi.org/10.1093/biomet/20A.1-2.175>. Retrieved May 10, 2019, from <https://errorstatistics.files.wordpress.com/2019/01/neyman-pearson-1928-part-1.pdf>
- OECD. (2016). *PISA 2015 results: Excellence and equity in education (Vol. 1)*. Paris: OECD.
- Pološki Vokić, N., Obadić, A., & Sinčić Ćorić, D. (2019). Gender equality initiatives and their benefits. In *Gender equality in the workplace*. Cham: Palgrave Pivot. [https://doi.org/10.1007/978-3-030-18861-0\\_5](https://doi.org/10.1007/978-3-030-18861-0_5)
- Prime, J., Salib, E. R. (2014). Inclusive leadership: The view from six countries. A *Catalyst Report*. Retrieved May 15, 2019, from [http://www.catalyst.org/system/files/inclusive\\_leadership\\_the\\_view\\_from\\_six\\_countries\\_0.pdf](http://www.catalyst.org/system/files/inclusive_leadership_the_view_from_six_countries_0.pdf).
- Rao, S. (2016). How statisticians can develop leadership by contributing their statistical skills in service of others. In A. L. Golbeck, I. Olkin, & Y. Gel (Eds.), *Leadership and women in statistics* (pp. 307–319). Boca Raton, FL: CRC Press.
- Samuel S. Wilks Award. (1997). Retrieved July 25, 2019, from <http://www.amstat.org/careers/samuelwilksaward.cfm>. (Also reported in *Amstat News*, October 1997, No. 246, p. 7).
- Stoet, G., & Geary, D. C. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. *Psychological Science*, 29(4), 581–593. <https://doi.org/10.1177/0956797617741719>
- Sugiyama, K., Cavanagh, K. V., van Esch, C., Bilimoria, D., & Brown, C. (2016). Inclusive leadership development: Drawing from pedagogies of women's and general leadership development programs. *Journal of Management Education*, 40(3, Special Issue), 253–292.
- Symanzik, J., & Vukasinovic, N. (2011). Peace through Statistics. *AMSTAT News*, 2011, 10–14.
- Walhout, A. J. M. (2011). Gene-centered regulatory network mapping. In J. H. Rothman & A. Singson (Eds.), *Methods in cell biology, Caenorhabditis elegans: Molecular genetics and development* (Vol. 106, pp. 271–288). Amsterdam: Elsevier.
- Wasserstein, R. L. (2016). Outlook on statistics leadership. In A. L. Golbeck, I. Olkin, & Y. Gel (Eds.), *Leadership and women in statistics* (pp. 3–8). Boca Raton, FL: CRC Press.

# Independence and Diversity as Taught by My Mentors



**Bin Yu**

**Abstract** In this chapter, the author reflects on her formative childhood experience during the tumultuous Cultural Revolution in China (1968–1978). She makes the case that the lessons of independence and diversity during this period from her mother, nanny, and others shaped her as a person and as a researcher.

People have always interested me from a very young age. They were the first mysteries for me to try to solve. Now, I try to solve mysteries in research as well as mysteries about my students, postdocs, and colleagues. In my mind, they are not that different because I am equally curious about them, and I take realistic approaches to both by gathering good data and relevant knowledge, using common sense and first principles, carrying out a rigorous investigation process, and wishing for luck.

In my memory, I was always an observer, observing the behaviors of people (data on reality) around me during my formative years in the Cultural Revolution. The Cultural Revolution was a costly and disastrous “social experiment” that revealed so much about human nature: the bad and the good. I have a selective memory to remember mostly the good and kind people.

I was 3 years old when the Cultural Revolution started in 1966 and was 13 when it ended (Photo 1).

Chinese universities stopped for ten years during that time. My family was labeled “bad” people mainly because my parents were intellectuals who worked for an agriculture university in Harbin. At some point, both my parents were taken away by the red guards who were students of my parents to some make-shift jails in buildings of the university, and my father (Dibei Yu, 余棣北) never came back. I now believe that he was tortured and killed by the red guards.

When my parents were taken away, I was 3–4 years old, and my sister (Mei Yu, 郁梅) was two years older. We had a very kind and wise nanny, Zhiying Zhong (钟志英), whom we called Laolao—the word for maternal grandmother

---

B. Yu (✉)

Departments of Statistics and EECS, UC Berkeley, Berkeley, CA, USA

e-mail: [binyu@berkeley.edu](mailto:binyu@berkeley.edu)

**Photo 1** Bin Yu with her mother and older sister. The red scarfs are distinctive features of the cultural revolution and later



in northern parts of China. The red guards asked her to leave us since she was from a “good” family. She refused and used her own savings to feed us in addition to selling valuables including furniture to make ends meet. She would purchase inexpensive bones from the market to make soup, and so we could get calcium and other nutrients. Food was rationed: 1 kg of rice, 4 kg of flour, and some corn and sorghum per person per month. Meat and cooking oil were rationed too:  $\frac{1}{4}$  of a kilo of cooking oil and  $\frac{1}{2}$  of a kilo of pork per person per month. Laolao was not formally educated, but was one of the most intelligent people I have ever met. She was from Anhui province near Huai River, which often flooded the farms in the rainy season and made the region poor. She lost her husband in her early 30s. After that, she left Anhui to be a servant in big cities and sent money home to support the family of her husband, and this support of her family continued into her old age. When I was in elementary school and middle school, I used to write letters for her to send home to her nephew who also came to visit us in Harbin after the Cultural Revolution. Her family used to send us dried sweet potato chips that were hard to chew, but tasty. Laolao was a small beautiful woman in her early 70s. She always dressed up neatly, had a traditional hair bun, and made her own traditional blouses in white, gray, blue, and black depending on the season. LaoLao became a regular member of my family and a mother figure for me. As a Buddhist, she taught me basic principles of living, ones that she lived by herself: be kind and help others regardless of who they are.

We shared a flat with two other families, each occupying a room in the flat with a shared kitchen and shared toilet. One family was labeled “good” because the father was a plumber. They were always helpful to us and treated us with respect. In fact, their second daughter was my best friend—the only friend that I remember during



that period before my family moved to a farm from Harbin where the university was. The other family was not in as much trouble as mine, but in trouble nevertheless. They often took advantage of us. For example, they forced Laolao to fill up their thermal bottle first if Laolao boiled water, and their young son had to eat with us. Laolao hurt her back one day by lifting the boy to the chair, and that back problem remained with her into her old age.

Not long after my father's death, my mom (Xiaomin Yu, 郁晓民) was released from custody to come back to us and moved the family with Laolao to Xianglan (香兰) Farm near the city of Jiamusi, which was close to the border with Russia. The entire faculty and their families from the university were moved away from Harbin city to be reeducated by the farmers. The move to Xianglan was by train, the first time for me to take a train, and I was 5. A nightly image became carved in my mind: from the train window, it was half dark, and I saw dreamy bluish fogs surrounding the bluish mountains as the train passed. When we arrived in Xianglan, my family of four was assigned a very small room in which most of the space was filled with a brick bed (that was heated when cooking was done) upon which we all slept. There was only a very narrow strip left, where my mom and grandma had to dig into the mud ground to fit the only furniture that we brought—a tall Russian cabinet that was a gift when the Russian agriculture experts, for whom my mom was a translator, left in 1957. The first night was very cold—there was a blizzard, and the cold air kept seeping in from the ceiling so that my mom and Laolao had to stand on chairs on top of the bed to paste newspapers on the ceiling to keep the wind out.

Xianglan Farm used to be for prisoners, and they were able to live on the food that the farm produced. Shortly after the professors and families arrived, the farm was not able to be self-sufficient anymore: the professors knew agriculture in theory, but not in practice. As a matter of fact, the optimized “seeds” of tomatoes they brought did not grow well in the local climate of the farm since they were bred for the climate of Harbin. Xianglan Farm was surrounded by mountains, and there were four huge boulders that were visible from a distance. I heard stories about the famous anti-Japanese heroine Zhao, Yiman (赵一曼), who carried out guerrilla warfare against Japanese invaders as a young commander in her late 20s in the four boulder areas. Many years later, I read in detail about her wealthy family background in the Sichuan province and her incredible bravery and courage after being captured and tortured by Japanese soldiers. She died when she was 24 years old in the hands of Japanese invaders who also carried out cruel and inhumane biological experiments on her. I admire her tremendously to this day.

I started elementary school at Xianglan Farm that was organized into different villages with headquarters. The village that my family was in started a class for my age group when I was at the elementary school age of 7. My sister had to walk 45 min each way to the headquarters in order to go to school and often in blizzards in winter times ending up with frost bites on her hands and feet. My classroom was half of the dining hall for the teenagers from the Shanghai area, where they were to be educated by the farmers. They didn't like to share and fought with us, for example, when coal for heating arrived. One year before the Spring Festival, the pigs slaughtered for the festivities screamed so loud that the class had to be stopped,

which did not make me unhappy. Card games were forbidden during the Spring Festival, but I still played some with friends. I loved card games and was very good at them. When classes resumed, our teacher asked the students who played card games, and a fellow student reported me. There was not any serious punishment that I remember, but it was a first taste of betrayal of trust.

Perhaps, this incident was the reason that years later in middle-school, when my teacher asked me to report on other students' bad behaviors during self-study sessions, I was never able to do it.

Life on Xianglan Farm was rough, with no running water and toilet in our living quarters. Before winter time, men had to go to the mountains to cut firewood, and my mom Yu, Xiaomin, was the "man" in the family. She went and brought back firewood even though she often fell and rolled down the slopes with the wood, as I learned years later. Laolao tried her best to help, and her health deteriorated as a result. She grew hens, ducks, and geese, and so we could have eggs to eat. My sister and I helped by collecting and chopping wild vegetables for the animals.

My mom seemed to me to be made of steel and love. She lost her own father Hua Yu (郁华) when she was 13. He was assassinated in front of his house in Shanghai, as one of the remaining judges of the Kuomintang nationalist government during the Japanese occupation of Shanghai in the late 1930s. Having his court inside the French enclave, he protected people in the resistance and was threatened by a letter with a bullet. He did not bulge and lost his life as a result. When my mom was 17 years old and in high school, she was active in the protests against the Kuomintang government and was put on their blacklist. She had to escape to the region controlled by the communists. In 1949, she returned to Shanghai with the People's Liberation Army. After college, she volunteered to move to Harbin to help build the new agriculture university, where she met my father who also came from Shanghai.

During our time in Xianglan, I watched my mom in awe. As the manager, she turned a troubled dining hall around in no time for the youngsters from the Shanghai region who were "reeducated" by the farmers. Then, she was asked to become a Russian language middle school teacher (because she was a Russian translator before becoming an administrator), and she was much loved by her students. Her versatility was truly impressive, and her success had a lot to do with her warm and disarming personal style. It was hard to believe that before the Cultural Revolution, she was a department chair of basic education in the university. Most of all, I saw first-hand how she devoted her energy to helping others in need, while she had to go through so much pain herself. If you met her, you would not have been able to tell.

In the early 70s, my mom was transferred to a Chinese medicine University in Harbin to be a department chair, earlier than most of her colleagues, because life was tough in Xianglan for us without our father. I began my third grade in Qingbin Elementary School in Harbin. My classmates' fathers mostly worked for a local pencil factory. At the beginning of every academic year, our teacher would ask all the students to stand up if they hadn't paid the 5 RMB tuition. It was difficult for a student whose father was making about 40 RMBs a month to support the family since mothers often did not work. I felt very fortunate that I did not have

to stand up and feel humiliated, because my mom as a professional woman made a good salary even though my father had died. I still remember the image of my fellow students standing up around me, and it was perhaps then that I decided that I would become economically independent no matter what. My mom also gave me her unconditional love. I was very clingy to her by insisting on following her everywhere, way beyond what a normal child of the same age would do. I believe now that I was afraid of losing her as well. Many others urged my mom to push me away since it was not “normal”. My mom took me everywhere until I was ready to be on my own. My mom’s unconditional love (and Laolao’s) was the only thing I needed for a long time: it gave me confidence and the space to become my own person. I enjoyed school very much, and my excellent school performance also made my mom and Laolao happy and proud. Their pride further motivated me. When I became a mother, I knew the most important thing that I wanted to give my children is my unconditional love.

It was during my time in elementary school that my first attraction to math happened. It was when my cousin Dawei Huang (黄大威) gave me a book called “foundations of applied math.” I remember using the exponential and logarithm tables endlessly to convert numbers back and forth. The mechanistic operations must have given me peace of mind in a time of turmoil. Now, I do not quite understand why I found such exercises so interesting. My conjecture is that the conversion might have been the only part that I could understand in the book since it was not an elementary book. In 1975, I entered the neighborhood middle school, the lab school of the Harbin Normal University, which was a magnet school before the Cultural Revolution.

In 1976, Mao died. I was in a PE class running in a track field when the school’s loud speaker called for all students to return to classrooms, and we heard the news of his death. To us, the sky had fallen, and it took a long time before the kids stopped crying. The Cultural Revolution officially ended in 1976 when the “Gang of Four” was arrested. Normalcy started to return afterward.

A talented young teacher Jianye Chen (陈建业) was hired to be a substitute mathematics teacher in my middle school, and his mom was a beloved history teacher in the same school. Even though he had suffered polio, he was still sent away from Harbin to be reeducated by the farmers. He never taught me as my math teacher, but he organized math competitions that I participated in, and I did well in the first one—fourth in my grade, if I remember correctly. He followed up the math competition with a math club, and we did many polynomial factorization problems in the club. The exercise problems were “copied” by him writing very hard on a stack of special papers, and I can still see his beautiful handwriting of the symbols in my mind. After the first competition, my performance was not in the top few. I remember that I was in the eighth place or something, at least for another competition. But Teacher Chen for some reason kept me on the team even though I did not go on to win any competitions at the district level either. I don’t think I liked competitions then or now. My mom went to talk to him and asked him to tutor me after school, and he did. For the summer of my second year in the middle school, he

lent me a plane geometry book printed before the cultural revolution by Chunfang Xu (许纯仿). I did all the problems in the book that summer and loved it!

Before the summer of high school, my mom found a new job in Beijing. I joined her in the spring of 1978 and stayed with her big sister—the wonderful painter and writer Yu Feng (郁风)—since my mom did not have an apartment of her own. In fact, the four members of my family were in four different places: my mom was in a dorm, Laolao was with a friend's family, and my sister stayed with the amazing and kind physics teacher Yingmei Nie (聂颖梅) in the No. 2 middle school of Beijing. Nie taught my cousin Dawei and her brother Dongdong (冬冬). My sister and I also went to the same middle school. That summer before my high school, I went back to Harbin. I stayed with my second auntie Junmin Yu (郁隽民), and Teacher Chen taught me the entire high school math in one summer. That really put me ahead of my class in high school (of two years) and set me on the path to become a math major in Peking University in 1980. I put PKU math as my first choice on my college application in order to realize Teacher Chen's dream—he was not able to go to PKU because his father was labeled a rightist in the 50s. Teacher Chen continued to write me letters while I was in college. He made suggestions for me to go to graduate school and study in the U.S., which I did. I am forever grateful for his kindness and mentorship.

People made choices in the horrifying circumstances of the Cultural Revolution to be good and kind in the essence of the words, not the labels. I wanted to be like them when I grew up: be a good person and be kind and help others less fortunate. I also learned that I wanted to be economically independent, and so I could feed my kids like my mom did with a professional job after my father died. I also learned later from my amazing mom that one should forgive for the sake of one's happiness. My mom told me that she forgave the people who had things to do with my father's death and came to her for forgiveness after the Cultural Revolution.

Diversity in both the academy and industry is about the intellectual ideas and concepts and practices that are embodied by the people who have them. Without diverse ideas, there is much less of a chance to have innovations and creativity to move disciplines and companies forward. Right now, data science is playing a central role in most of the fields of the academy and an ever increasing number of units in industry and government. Statistics is an indispensable pillar of data science, which is intrinsically transdisciplinary. People are again at the center of data science: people from different fields and/or units need to communicate and work together seamlessly to form a team brain to tackle effectively ever more complex problems in science, medicine, engineering, social science (including problems from democracy), health care, climate change, and immigration. It is an exciting and challenging time for statisticians. Will we be important team members and/or leaders? It is up to us, and we have to change how we do things and relate to other people in other fields. As urged by the recent NSF report, "Statistics at a crossroads: who is for the challenge?" (<https://hub.ki/groups/statscrossroad/overview>) that I was quite involved in, practice has to be the focus of statistics and one cannot embrace practice without realism.

I would not have chosen in a thousand years to live through the Cultural Revolution and lose my father, but I have to admit that living through that period has prepared me well for what I do in research and teaching throughout my academic life and especially in today's data science research. First of all, I believe that I have a good sense of the kinds of people with whom I work well based on universal good human qualities that defy race, culture, and gender. Second of all, I am very comfortable doing things my way and not in the crowd—because my family was an outcast for a long time during the Cultural Revolution. This sense about people and independence in thinking to follow curiosity and at the same time face reality led me to two great advisors for my Ph.D. in Statistics at Berkeley, Professors Lucien Le Cam and Terry Speed and my third de facto advisor Dr. Jorma Rissanen from IBM Research. These traits also led me to closely associate with many inspiring colleagues at Berkeley and other places in the US and internationally, and they led me to make many wonderful friends in graduate school, at work, and among parents of my kids' friends.

These two traits and a sense of professional responsibility to help others have led me to exciting data science projects in precision medicine, developmental biology, and neuroscience. They also led me to adopt amazing mentees among students and junior researchers from underrepresented groups including women. Building on transdisciplinary projects, I have developed with my students and collaborators the PCS framework (Yu & Kumbier, 2020) that is built on the three principles of data science: predictability, computability, and stability (PCS). The PCS framework is a step toward veridical data science, which “extracts reliable and reproducible information from data, with an enriched technical language to communicate and evaluate empirical evidence in the context of human decisions and domain knowledge”. The PCS framework contains workflow and documentation. The former covers the entire data science life cycle from problem formulation, data collection, data cleaning, data visualization, modeling, post hoc analysis, interpretable conclusions, to new or modified problem formulation. The documentation records the arguments and human judgment calls in the entire data science life cycle in narratives and codes to justify assumptions and explain choices. This is my attempt at taking intellectual leadership to do reliable, reproducible, and interpretable data science. As a senior statistician, I am also propelled by the desire to give back to the community by taking on leadership roles such as the President of IMS in 2013–2014 when I delivered an IMS presidential address called “Let us own data science” (Yu, 2014).

All of us bring our personal experiences to the statistics profession, and I have tried to keep who I am in my professional life, because I believe my experience as well as those of all my colleagues enriches our community. In particular, curiosity about unknown phenomena in nature and beyond—pursued by diverse, open-minded, and well-connected people—drives the intellectual diversity that is badly needed to embrace the call to focus statistics on the practice (reality) or to be a leader in data science.

My experiences in my childhood as well as in my professional life have led to the following useful principles to advance our diversity and inclusion goals:

- Push back on the spot, if possible, when explicit and clear implicit biases happen to you and others around you.
- Find allies who can push back effectively on their own or with you.
- Choose your battle since you have finite energy and it can ultimately be more effective and persuasive to do so.
- Be patient for progress to happen and forgive to be happy.
- Have compassion toward people who harbor explicit and implicit bias including yourself.

## References

- Yu, B. (2014). *Let us own data science*. Sydney: IMS Presidential Address. Retrieved from <https://imstat.org/2014/10/01/ims-presidential-address-let-us-own-data-science/>
- Yu, B., & Kumbier, K. (2020). Veridical data science. *PNAS*, *117*(8), 3820–3829. With QnAs with Bin Yu 3893–3894.

# My Journey to Leadership



Reneé H. Moore

**Abstract** In this chapter, I share 21 lessons learned during my journey from a Bennett College student to academic research 1 faculty. The lessons encourage me to plant seeds early, think outside the box, and invest time and resources to recruit diverse leaders and create and maintain a supportive inclusive environment.

I did not grow up or grow in my career with the desire to be a leader. The leadership positions I have held are a result of two things: (1) mentors and peers believing in me, recognizing my leadership potential, and showing or providing opportunities for me to lead or (2) doing what I'm passionate about and filling the shoes of a leadership position when there is a vacancy and there is important work to continue. In this chapter, I will share *My Journey to Leadership from an All Women's HBCU to Academic Research 1* and through my journey share my highlights (my lessons learned) to promote diversity and inclusiveness in organizations and teams and in leadership.

I grew up in Voorhees, NJ, which is a suburb within 15 miles of Philadelphia, PA. As a school aged child/teenager, I do not recall taking on any leadership roles. I was not the student in AP (advanced placement) classes or the popular student playing sports, and I can still count the number of Black students in my high school class (between 5% and 10% in a class of 350–400). I did not stand out, and no one encouraged me to stand out.

This all changed when I went to Bennett College, a small (~600) historically black college for women in Greensboro, NC. I remember being terribly homesick and wondering how in the world anyone could call Greensboro, NC, a city. As a Jersey girl, cities were Philadelphia and NYC, and I naively thought that all cities looked this way, with many tall buildings, lots of one-way streets, lots of traffic, and lots of things to do. It was October, and we had to meet with our advisors to plan

---

R. H. Moore (✉)

Department of Biostatistics and Bioinformatics, Biostatistics Collaboration Core (BCC), Emory University, Atlanta, GA, USA

e-mail: [renee.moore@emory.edu](mailto:renee.moore@emory.edu)

courses for the next semester. My academic advisor and Calculus I professor was Dr. Ray Treadway, a Caucasian man who spent his whole career at Bennett College and dedicated himself to the students there. Dr. Treadway and I discussed my classes for the next semester and beyond. He said, ‘you should take these classes because when you go to graduate school and earn your PhD . . . .’ I wanted to say, ‘Are you crazy? When I go to graduate school? I’m not even sure I’m going to stay at Bennett College!’ But I didn’t say that out loud because I thought that response would be disrespectful, and my parents taught me better. So, I just said, ‘Ok Dr. Treadway, I’ll enroll for these classes next semester.’

**Highlight Lesson 1** As an educator or supervisor, *plant seeds early*. Identify potential leaders under your mentorship or supervision early, and set goals early, sometimes even before the mentee knows such goals exist or are even achievable.

Aside: Conversations with families are important. My parents were educators (Ginny, a retired high school guidance counselor; and Richard, a retired middle school vice-principal). Though they didn’t know what I wanted to be when I grew up, my parents believed a strong foundation in mathematics was essential. Much to my shame, they had me (and my sister Jennifer, who is now a lead mechanical engineer) retake Algebra I in ninth grade because they said the middle school and high school courses used different books. They also required me to retake Calculus I in my freshman year of college because, again, the book was different in high school and college, and if we were to major in anything requiring a math background, then taking Calculus over would make our foundations stronger. I also remember my mom not letting me take Honors Geometry (again to my shame) because she thought the CP (college placement) Geometry was more practical and useful for the future. I am blessed because I had educated parents (both have M.S. degrees), but many of our diverse mentees are still first-generation college students and first-generation graduate students who need guidance beyond what their families can provide.

**Highlight Lesson 2** To build a pipeline of diverse statisticians and leaders, *we must reach back sooner* (e.g., before high school) *and incorporate families* in conversations about coursework, careers, etc. As a former co-chair and ongoing committee member of the ENAR Fostering Diversity in Biostatistics and as a former chair and ongoing supporter of the ASA Committee on Minorities in Statistics, or just say as someone who has devoted part of her career to recruiting and retaining the next generation of diverse statisticians, I find many hard working, passionate, talented students who do not have the coursework required to enter graduate programs in our field. Had I met them sooner in their journey, then in middle school, high school, and/or college, they could have taken the courses and gained the experience to prepare them to enter graduate programs or the workforce in the mathematical and statistical sciences.

**Highlight Lesson 3** *We must meet mentees where they are*. I’ve heard Dr. Sastry Pantula, currently Dean of the College of Natural Sciences at California State University, San Bernardino, and many others give presentations reminding us that



the students who have the potential to be successful and be leaders come in the door with many different backgrounds and different technical and nontechnical skills (or deficits). It is our job to make sure that, despite where each student starts in our program, they all exit our door with the same skill set and that we retain each student who enters into our programs. To do this successfully, we must work hard to understand the diverse backgrounds of our students (e.g., education, race/ethnicity, nationality, resources, and learning styles) and then provide the resources necessary for each student or employee to address the unique or collective diversity of the individual or cohort entering one's institution. Equality is providing all students the same thing, but equity is providing each student what he/she/they need to be successful. In order to even get the students or employees in the door, we also must constantly evaluate the criteria we are requiring to enter in the door. If you are in a place and you're surrounded by the same type of students and employees, then one reason may be that the entry criteria only permit one type of student or employee.

**Highlight Lesson 4** *Evaluate your entry criteria* to be sure that the criteria are diverse enough to welcome and retain a diverse and inclusive student population or workforce.

As I moved through the semester, some students in my class would tell me that Dr. Treadway taught the class for me. In the beginning, I had no idea why they thought that, and I didn't think it was fair. It's still not a fair comment, as Dr. Treadway is an excellent teacher and he was there for all of his students, meeting each where she was. However, Dr. Treadway was not afraid to challenge all of his students and this meant that there would be homework problems or test questions that only a small percentage of the students would probably get correct. As Dr. Treadway went over homework or exams, he would say something like, 'the students who earned an A were able to answer these questions.' Toward the end of the semester, I realized that the comments about the class being taught for me were in reference to these comments about those who earned an A'.

**Highlight Lesson 5** *Stretch each and every student/mentee.* Everyone can't earn an A on each assignment, and that is OK, even though everyone will not be happy. Our future leaders need exercises and experiences that stretch them to reach their full potential.

I didn't know what I wanted to be when I grew up. The only thing I knew was I loved running home each day after school and sharing my lessons with my sister who is 18 months younger than me and was one grade behind me. When I entered Bennett College, I declared three majors: mathematics, secondary mathematics education, and psychology. My parents and mentors like Dr. Treadway encouraged me to attend summer programs. Actually, this was nothing new for me during the college stage. Every summer from elementary to high school, my parents wanted my sister and me to attend an academic enrichment summer program. As we became older, my parents sought out programs where we would see other students who looked like us and who were excelling in mathematics and language arts.

I have fond memories of being a part of the Prime summer program in middle and high school, and really, this was the first time I was surrounded by other

“overachieving” Black and Hispanic students, all of us from the greater Philadelphia area who earned A’s and B’s during the school year. I remember for the first time thinking maybe I am “cool”, whatever that means, and it was fun to be surrounded by other students who looked like me and also seemingly enjoyed math and science. In my senior year of high school, I went through extensive interviewing to be chosen as part of the INROADS Philadelphia program (<https://inroads.org/>), which led me to being an intern for CONRAIL. The summer before entering Bennett College, I was an intern in Human Resources. The summer before my sophomore year, I was an intern in the Accounting Department. From those experiences, I learned that corporate America was not for me and that accounting was not how I wanted to use my mathematics.

Dr. Treadway encouraged me to apply for the Mellon Mays Undergraduate Fellowship (MMUF) program (<https://www.mmuf.org/>), whose goal is to increase diversity in the faculty at higher education institutions. I was one of the few math and science majors, and now sadly, the program does not include math and sciences, only humanities and social sciences. During the Summer Institute of the MMUF program, where all fellows from UNCF’s school gathered for the month of June, my love of teaching and desire to one day become a professor were renewed. I learned what it meant to engage in research. I learned how to communicate my passion of mathematics to those who didn’t like math and were afraid of it (even some of the faculty). I became a part of a cohort of students who looked like me, we have traveled together from the time of being sophomores in college through the time of being professors, and many are directors, chairs, and deans at their institutions (Photo 1).

I gained two mentors, Dr. Cynthia Neal Spence (Spelman College, MMUF-UNCF Coordinator) and the late Dr. Rudolph Byrd (Emory University, MMUF-UNCF Summer Institute Director). The MMUF programs provide a stipend for their undergraduate students and a faculty mentor for the student to engage in a research project of the student’s choice. My first project was examining whether SAT scores are a predictor of student success in his/her first college math course. Dr. Treadway, of course, was my MMUF mentor when I returned to Bennett College. The summer after my junior year, I attended the Harvard Summer Program in Biostatistics (Dr. Louise Ryan) and finally found something I loved as much as teaching biostatistics. In my senior year of college, my MMUF project was learning more about biostatistics with the book *Case Studies in Biometry* as my course text under Dr. Treadway’s tutelage.

**Highlight Lesson 6** Fully encourage your students and employees to gain as many experiences as possible, so they too can find their passion. How can one do this? Keep a list of experiences available (often, my list grows through discussions with my students and colleagues at conferences); and provide the opportunities in your institution (e.g., rotations through different departments or research groups like I did with INROADS and CONRAIL). Today, this means that I provide as many students (high school, undergraduate, and graduate) as possible with hands on experiences as a statistician/analyst working with me and a clinician to provide insight into a

**Photo 1** Reneé Moore at the 2016 MMUF UNCF Programs Conference Celebrating 100 Ph.D.'s



research question in public health or medicine. We must understand that sometimes, these experiences may take away from the current task. However, in the long-term, if the student/employee finds what he/she/they are passionate about and are able to incorporate that in their current tasks, the productivity is 1000-fold.

As I mentioned early on, I never planned to be a leader, and still, to this day, I actually prefer to be in the background. Many who know me might be surprised by that comment because I am able to comfortably teach in front of a class of over 100 nonstatistics majors, or lead a workshop of over 150 from behind the scenes and also very much up front as the M.C. for the day (e.g., ENAR Fostering Diversity in Biostatistics Workshop, StatFest of the ASA Committee on Minorities in Statistics), or network during a large conference mingle (e.g., JSM). Bennett College prepared me to be a leader.

I once heard a president of Bennett College say something to the effect of, ‘we take the seemingly average young lady, help her to see her talents, give her resources, opportunities and support, help her build confidence, and watch her emerge as a leader.’ Though I always performed well in classes prior to and during

Bennett (e.g., earned A's), I was not the leader of any group or organization prior to Bennett and had no intentions of being one. However, Bennett did not let me sit and hide in the background. My parents and Bennett professors taught me that, if you're serious about your profession and your community, then join others who are also serious and working to improve their communities and give opportunities to others.

Thus, as a math education major, I joined the Student North Carolina Association of Educators to do meaningful work in our community, and I also joined the National Council of Negro Women. After the second semester of my freshman year, the juniors and seniors in our college chapters of these organizations saw my work ethic and listened to my ideas, and without my knowing it, groomed me to eventually serve as chapter president of each. It started with asking me to join a subcommittee, then lead it, then be on the executive committee (e.g., secretary and treasurer), and that led to eventually being the president. If they had asked me to be on the executive committee early on, I likely would have said, 'No'.

Fast Forward: I became so involved in ENAR (currently Treasurer, previously Regional Advisory Board-RAB member- appointed, RAB chair, Regional Committee-RECOM- elected); it was the same as asking me first to be a part of the ENAR Fostering Diversity in Biostatistics Workshop (FDB) planning committee and then to cochair it, which also meant presenting in front of the ENAR Executive Committee, RECOM, and RAB. I often joke with Dr. Scarlett Bellamy (past ENAR president, current Associate Dean for Diversity, Inclusion and Faculty Development at the Drexel University Dornsife School of Public Health) that she took a naïve first year faculty member and with a simple ask to join FDB set her up into a leadership career with ENAR. I'm so glad that Scarlett set me up. It has been an honor to be ENAR RAB Chair and launch initiatives such as the Poster Award Competition, the Council for Emerging and New Statisticians (CENS: graduate students and early graduates), and WebENARs. It has been an honor to be a part of FDB for 20 years now, first as a senior in college, and to watch myself grow up with ENAR and now watch others after me complete their graduate programs and grow up in ENAR, too (Photo 2).

Just as my Bennett sisters and Scarlett "set me up" for leadership, I too have "set up" mentees and colleagues younger than me who would have been comfortable staying behind the scenes and now are current and immediate past leaders of FDB and ENAR. I've made a point to "set up" those who also share my passion for diversity, inclusiveness, and humanistic leadership so that, for example, FDB and CENS, which help create a community of diversity and inclusiveness for students and early career professionals will remain viable, humanistic, and diverse.

**Highlight Lesson 7** *Take notice of those working behind the scenes, fully engage them, fully encourage them, give them credit for their contributions, and prepare them for diverse, inclusive, and humanistic leadership so that you have someone to pass the torch to and someone to continue this important work. I have seen organizations become inactive for years or even dissolve because no one was identified and trained to be the next leader. I have seen organizations, departments, and institutions which were leaders in the recruitment and retention of diverse*

**Photo 2** René Moore featured by the International Biometric Society in 2019



International Biometric Society

Send Message

Nonprofit Organization

International Biometric Society April 24 at 6:48 PM ·



René H. Moore, ENAR Treasurer, Associate Professor of Biostatistics at Emory University, Atlanta, GA, US, is passionate about training students to utilize biostatistics to solve public health mysteries in collaboration with clinicians. Home mysteries solved by my kids 😊 #IBSWomen #IBSstats #May12 #WomenInMaths #WomenInMath #May12WIM #emoryuniversity

students and employees lose this reputation because the person who led the charge to create an inclusive, diverse, and humanistic environment left. As I pass the torch of leadership, I let the next leader know that part of their job is to identify and train the next leader and to identify the next set of committee members, as a leader is only as good as the team around them.

**Highlight Lesson 8** *If only one person in the organization is dedicated to an inclusive, diverse, and humanistic environment, the institution doesn't change, and without that person, the institution goes back to the same environment. The goal of a diverse, inclusive and humanistic environment must be the goal of leaders in the environment. They must support and provide the resources (e.g., time and financial) for team members to help with this goal and demand that all in the environment respect this goal.*

Bennett College granted me the ability to learn and grow in a safe, supportive, embracing, and encouraging environment. Though a small private college, they poured resources into me that are both measurable and nonmeasurable. For example, after I decided Biostatistics was for me, Jovonne (Foster) Williams, a Bennett

alumna finishing her master's program at Harvard Biostatistics, told me there would be a workshop at a biostatistics meeting (ENAR) and that I should attend. She said I'd meet other diverse scholars like me who were interested in learning about graduate programs in biostatistics, as well as current graduate students from underrepresented backgrounds and faculty from universities who were interested in recruiting diverse students. This was the first meeting of what the next year would be called the ENAR Fostering Diversity in Biostatistics Workshop, which is now an annual event at the ENAR Spring Meeting celebrating its 20th anniversary. I was excited about the possibility of attending but had no funding to attend, and this was before the NIGMS NIH grant that has traditionally funded attendees. Jovonne reached out to our Bennett College President Dr. Gloria Randall Scott, and next thing I knew I was headed to Atlanta for the ENAR Diversity Workshop. By the conclusion of the Workshop, my passion for Biostatistics was renewed, I knew I was not alone and that I had a community of diverse biostatisticians, and I knew which graduate program was the right fit for me.

**Highlight Lesson 9** *Be the mentor or supervisor who without hesitation finds the resources needed for a mentee or employee to attend an event that will help propel them to the next stage, especially if it provides a community of support beyond what the current institution can provide. Be the peer mentor who identifies others who can provide the resources for these opportunities.*

After attending the Harvard Summer Program in Biostatistics, I just knew that I would attend Harvard to pursue my PhD in Biostatistics. During the fall of my senior year, there was a graduate and career fair at Bennett. One of my math professors Dr. Bampia Bangura excitedly came up to me and said, 'Renee' go find Ms. Kharen Fulton from Emory University to learn about their Biostatistics graduate program.' My response was, 'Dr. Bangura, you know I'm going to Harvard.' Dr. Bangura responded back, 'Renee' go talk to Ms. Fulton!' And, so I did. I had a lovely conversation with Ms. Kharen Fulton, and though I was going to Harvard, I promised Ms. Fulton that I would apply to the Emory Biostatistics program. In order to keep this promise, I had to overnight mail my application to make the deadline. I procrastinated because—well, you know—I was going to Harvard. Harvard, Emory, and other programs invited me to their visit day. I was able to secure the Packard HBCU Graduate Fellowship, which I could take to whichever university I chose. After my visits and learning what support schools would give beyond my Packard Fellowship, I narrowed my choices to Harvard and Emory. Harvard because of the amazing experience I had in the summer program and Dr. Louise Ryan's ongoing support and communication with me. However, when I visited Emory, it felt like home to me. It felt like a Bennett College to me in that: it was small; the professors seemed genuinely interested in me for me and not because I was this Black girl who happened to also be a math major with a 4.0/4.0 GPA; the professors seemed to have an open door policy just like Bennett professors; the professors and students seemed to really know each other; and the students seemed to really know each other and were supportive of each other. It seemed like a warm community of people doing great competitive work but not so competitive that they couldn't work together.

I recall during the visit to Emory, Dr. Lance Waller said to me, ‘I saw in your personal statement you reviewed the Case Studies in Biometry book. My dissertation was in there.’ He must have seen my face go blank and had known I was clueless. He graciously smiled back and said, ‘oh don’t worry I know there were a lot of chapters in that book.’ Then, he changed the subject, and we continued with a great conversation about biostatistics, graduate school, and life. These are conversations I can still have with Lance today. I went back to Bennett and opened up the Case Studies in Biometry book, and Lance’s dissertation was Chapter 1! I was mortified, but at the same time, I was like, ‘wow, Dr. Waller could have made me feel terrible and embarrassed me, but he didn’t.’ Dr. Waller instead immediately made me feel comfortable and continued to engage in conversation to learn about me and make sure he answered any questions that I had. To this day, I still consider Lance one of my mentors. He was a favorite professor of mine, while I was a graduate student at Emory, he was a senior person in ENAR when I became involved (Lance is a past ENAR president), and Lance is the chair who recruited me back to Emory as a professor. To this day, Lance is still a mentor who I can ask any of my seemingly dumb questions or present seemingly wild ideas, and I know he’ll never make me feel dumb. I know he’ll always provide me with insight from his knowledge and experiences.

**Highlight Lesson 10** *Be the mentor or supervisor who always creates a comfortable environment.* People cannot be themselves and cannot grow if they are afraid to speak up, ask a question, or give ideas out of fear, they feel they will walk away ashamed and humiliated. An open, comfortable environment is keys to recruiting and retaining students and team members from diverse backgrounds. We must each feel comfortable to be ourselves and offer our ideas that may be different from the majority or status quo.

When I visited Emory Biostatistics, the chair Dr. Vicki Hertzberg took me to a 1-1 lunch at what I remember to be a fancy restaurant. I was so shocked and flattered that the chair took time out of her schedule to learn about me and took this undergraduate student to such an impressive venue. Vicki, Lance, Kharen, and the other faculty and staff at Emory made me feel special and told me they were excited I was thinking about attending. Other places I visited made me feel like I was the one to be excited that they were thinking about giving me an offer. These were my reflections when I attended the ENAR Diversity Workshop, and after listening to the graduate student panelists, I was convinced of what my gut and heart were already telling me that Emory was the best fit for me. I felt bad telling Louise Ryan this, as I knew Louise was genuinely interested in me and that she would have supported me if I had chosen to go to Harvard, but I felt that by going to Emory, I had an entire Department and also, I had the support of Kharen. It turns out that the lady who I didn’t really want to talk to that day at Bennett because I was going to Harvard was the director of recruitment, diversity, and admissions at Emory’s Laney Graduate School. Kharen was also the advisor of the Black Graduate Student Association (BGSA). The community and support that Kharen and the BGSA provided me were essential to my success at Emory. I felt Emory was the

best fit for me given the amazing supportive close-knit environment at Bennett from which I was transitioning.

**Highlight Lesson 11** (Perhaps an extension of highlight eight) *When there is more than one person at an institution who believes in diversity and inclusion and more than one person working to recruit the next diverse scholar or employee, it is genuinely felt by the individual.* When individuals are truly interested in the diversity that one can offer, there is interest in getting to know the person and the person feels special and feels important and not just like he/she/they are present as the token diverse person. To recruit and retain diverse team members, the value of the uniqueness that each person brings must be valued at an institution level, by the majority, and not just by a few individuals.

As one enters the doctoral program with only a bachelor's degree, my first academic year of coursework at the master's level was quite manageable for me, as well as the first set of qualifying exams. However, by the middle of my third semester, I was shocked, and imposter syndrome hit me hard. By October of that year, I had convinced myself that there was no way I could pass my Ph.D. level qualifying exams the following August. That Spring semester, I even filled out paperwork to substitute teach in the local public schools and began planning the transition out of the doctoral program to becoming a high school mathematics teacher. Prior to the MMUF and Harvard summer programs, being a HS math teacher was my goal, and I wouldn't have to suffer through and be embarrassed when I flunked out of this doctoral program. This valedictorian who graduated as a double major with a 4.0 GPA earned two B that fall semester and was so sunk into imposter syndrome that I didn't even study for the qualifying exam. Yes, I failed. There was a problem similar to, but an extension of, a final exam question for a core Spring course. I was able to get the problem correct on the final exam, but 3 months later on the qualifying exam, I didn't even know how to start the problem. I was defeated and ready to leave.

However, FIVE professors at Emory reached out to me individually saying or writing that they knew my performance on the qualifying exam was way below my usual performance and that they know I could do better and how can they help. One professor, Dr. Amita Manatunga, did not wait for me to identify how she could help me, she told me that she had asked Dr. Andrew Hill, at the time a postdoc who also taught the first-year theory courses, if he would work with Amita and me to do an independent study to review the coursework and fill in my gaps for when I would retake the qualifying exam. I later found out that Amita also reached out to the graduate school and obtained funding for Andrew. Amita told me repeatedly that she knew I had the ability and the work ethic to pass the qualifying exam and be a successful biostatistician one day. She also did not let me stay in imposter syndrome—one Friday afternoon, Amita even told me, 'Don't eat, don't sleep, just do these problems over the weekend!' I knew Amita meant it, so I ate less, I slept much less, and I attempted to finish as many of the problems she gave me (I don't remember how many, I just knew it wasn't actually possible to finish all of them over the weekend). With Amita's belief in me, her snapping me out of imposter



syndrome, and being afforded the opportunity to work with Andrew, who is the best teacher ever: compassionate, kind, and empathetic and knows how to break the problems down to where your skill set and understanding lie. I passed my qualifying exam (and I was told with flying colors) the next time around.

*Highlight Lessons* Amita met me where I was (Lesson 3). She found Andrew and the resources to fund Andrew's time to help me close the gap from where I was and where I needed to be (Lesson 9). By letting me know I shouldn't eat or sleep, just do the problems, and giving me problems that were beyond my current skill set, Amita was stretching me (Lesson 5). Andrew provided a comfortable and safe environment for learning (Lesson 10). I was able to ask questions and grow. For Andrew, there was no dumb question. It allowed me to not feel dumb, get out of imposter syndrome, and believe I could master the material.

The Fall after I failed the qualifying exam, I also realized that I was alone. The two senior students who were peer mentors and friends to me (Jovonne Williams Foster and Dionne Price) had left the program or graduated, and the colleagues who I had formed study groups with during my coursework happened to be master's students who had graduated. I starting going to Black Graduate Student Association (BGSA) meetings. One hidden blessing of this was it allowed me more frequent interactions with Kharen. (Remember that Kharen Fulton was the person who came to the small HBCU Bennett College year after year to recruit me and others who had the potential to complete a graduate program.) Kharen provided such inspirational words of support each time we interacted, and she let me know that her open door, her listening ears, and her hugs were always available to me.

As for the BGSA members, though we came from all disciplines across the university (e.g., religion, political science, English, philosophy, and molecular biology), what we had in common is that we were all in the trenches of the ups and downs of a doctoral program, and we were the only or one of the only underrepresented students in each of our doctoral programs. BGSA provided intellectual exchanges (e.g., sharing our research and sharing tips on choosing an advisor or dissertation topic), community service opportunities, and also social activities. Two of my best friends to this day are from Emory BGSA. One, Dr. Keisha Haywood, was a political science major who now works for the UN providing her expertise to help warring African nations come to peace. The other was Dr. Denise James, an Associate Professor of Philosophy and Director of the Women's and Gender Studies Program at the University of Dayton. When BGSA needed officer positions filled, I filled them because I wanted this community of scholars to continue to be able to gather together, even after my time. In my last years, I was the BGSA president.

For several summers, I also was a graduate student assistant for the MMUF Summer Institute held at Emory University. This was the same program I attended after my sophomore year of college. This provided me continuous interactions with mentors Drs. Spence and Byrd and a community of other graduate students at Emory, many also in BGSA who were also MMUF graduate assistants. On some days, when I felt like giving up, being with Drs. Spence and Byrd who always reminded me that I would do great things as a biostatistician and being in front

of the MMUF undergraduates who looked up to me brightened my spirits and gave me what I needed to keep going. I became the lead graduate assistant by my third summer, and this provided me the opportunity to organize both peers (the other graduate student assistants) and undergraduates. It also allowed me to be the liaison between the faculty of the program and the graduate students and the undergraduates. BGSA and MMUF were there for me during my difficult times and provided places to celebrate, vent, and grow in leadership.

**Highlight Lesson 12** Growth in leadership comes from many different places. *We need continuous funding for HBCUs and programs like MMUF and continuous encouragement and resources for groups like BGSA and beyond. They provide important safe spaces for students who still often find themselves as the only one in many graduate programs and institutions, and they also provide foundations for finding and growing diverse leaders.*

**Highlight Lesson 13** We cannot underestimate the importance of diverse, humanistic, and supportive networks and environments. If your institution does not yet have such an environment, leadership must find a way to provide it until the institution gets there. *A diverse, humanistic, and supportive environment is essential for the growth of most diverse leaders.*

Attending the MMUF institute after my sophomore year of college, I confirmed my goal to become a tenure track professor. I entered into my dissertation stage still planning to be that tenure track professor. My dissertation research was going smoothly under the coadvising of Dr. Amita Manatunga and Dr. Bob Lyles. I also started working with Mr. Kirk Easley in the Biostatistics Consulting Center (BCC), gaining hands-on real experience working as a SAS programmer and data analyst with Kirk and physicians across Emory University and Children's Healthcare of Atlanta (CHOA). Prior to the dissertation stage, I also completed four semesters as a teaching assistant for Statistical Methods I, a core course for nonbiostatistics master's students that included both lectures and SAS labs. In the midst of the dissertation process, probably during the writing of my second chapter, I realized that I remained as passionate about teaching as I had been my entire life, but I was also passionate about being a collaborative biostatistician working closely with clinicians and public health practitioners to provide insight into medical and public health research questions. Developing new statistical methodologies was interesting and fun, but this was not my passion. I could not see my career, with daily or weekly primary responsibilities, to be developing new statistical methodology.

I was devastated. Suddenly, my career goal of being a professor did not seem to be a viable choice. I thought about teaching high-school mathematics again. Diverse high-school math teachers are needed, maybe even more than diverse biostatisticians. I reached out to my MMUF mentors, Drs. Spence and Byrd, and started by saying, 'don't be mad at me, but I can't plan to be a professor.' They immediately responded with positivity and encouragement. They said, 'we will never be mad at you for what you choose to do in your career. We will always be proud of you because you work hard, give your best, and make a difference with the work that you do.' Drs. Spence and Byrd also asked, 'are you sure, are you

positive, that you can no longer be a professor?’ I reflected on the question and realized, ‘no, I’m not positive.’ I remembered the graduate students I met at the Harvard Summer Program in Biostatistics and at the ENAR Diversity Workshops, who were at that time and now still are professors. At this time at the University of Pennsylvania Department of Biostatistics and Epidemiology, there were four underrepresented professors: Drs. Scarlett Bellamy, Knashawn Morales, Kimberly Sellers, and Mahlet Tadesse. They were a mix of tenure track and clinician educator (CE) track professors. Each one talked about the different tracks, why they chose them, the pros and cons, etc.

Hurray! I can be a professor again! There is space at Research 1 institutions for biostatisticians who want to focus on team science and teaching/mentoring!

A year or so later, I accepted a faculty position at Penn. Kim was in transition from Penn to where she remains today, Georgetown University’s Department of Mathematics and Statistics. She shared why she felt that was a better fit for her. By the end of our conversation, we both agreed that Biostatistics and the CE track was a perfect fit for me. I so appreciated the question from Drs. Spence and Byrd. In finding the answer to these questions, I found peer mentors, who I met through a community of underrepresented biostatisticians, who shared so openly and graciously with me. Without their sharing and insight, I may have abandoned the idea of being a professor of biostatistics, as most others I encountered were only familiar with traditional tenure track positions. Later, as I transitioned to NC State University (NCSU) on the teaching track, Dr. Kim Weems provided the same generosity in sharing about the different tracks at NCSU, the environment, etc. and supported my transition so much so that she went to look at rental homes for me and freely shared all her teaching materials with me before I had even arrived.

**Highlight Lesson 14** (a) *You can support someone’s growth even though you come from a different discipline* (Dr. Spence, sociology; Dr. Byrd, African American studies) *or are a peer*. A peer mentor is someone who is just a few steps ahead, as were the assistant professors at Penn who opened my eyes to different ways to be a professor and contribute to the academy. (b) *Be a mentor who supports diversity of positions and values, finding the best fit for others*. Diverse, inclusive leadership comes from diversity of perspectives and experiences. (e.g., Drs. Spence and Byrd were ok if I did not become a professor; Kim encouraged me to come to Penn even as she was leaving).

In my first faculty position at Penn, I was on the clinician educator track, as it allowed me to choose the balance between statistical methodology work and collaboration that was the best fit for me. In my second faculty position at NCSU (Department of Statistics), I was on the teaching track, as I felt that at Penn, I learned how to be a collaborative biostatistician but was missing teaching more broadly (e.g., undergraduates). I wanted to hone my craft of teaching from those who have dedicated their careers to teaching and statistics education (e.g., Dr. Roger Woodard, Dr. Kim Weems). Currently, I am a research associate professor at Emory University (Department of Biostatistics), and this allowed me to continue my collaborative research, teaching, and mentoring and spend about half of my effort as Director

of the Biostatistics Collaboration Core [BCC, the same acronym as Biostatistics Consulting Center I worked in as a student—we have since changed the C's to better reflect the team science we do (collaboration) and joining the SOM Cores].

I make it a point to share with students and early stage professionals that at (research 1) institutions, there are various ways to contribute to research and academia. I also make it a point to share that, however, in too many places, there is still not equity or inclusiveness in how those on nontenure track faculty are treated or valued.

I remember when I first chose to be on the nontenure track. Some would even introduce me saying something to the effect of, 'isn't it great how much Renee' is doing as a biostatistician for public health and medicine and for our profession, even though she's not on the tenure track?' I also recall being nominated for a leadership training program by my chair/head, and then, we were told I was not eligible because I was not on the tenure track. I was encouraged to speak to a woman associate dean whose office administered the program. She told me, 'nontenure track faculties are not eligible, because that track is for women who have children, and they can't handle the pressure of motherhood and tenure track, and so of course, they can't become leaders.' I let her know I had no children (at that time) and that I consciously chose not to be on the tenure track because I have always chosen tracks that allowed me to pursue my passions of collaborative research/team science and teaching/mentoring. I was enraged and thought about leaving that university, but I was reminded of how much my department valued me. Also, my chair/head identified a role that needed to be filled in the department for which I was a good fit, and the position made me a part of the department's leadership team and their monthly small group meetings.

**Highlight Lesson 15** To have a diverse, inclusive, humanistic leadership team, we must think outside of the box and *create and value positions that may be new or have not always been considered as leadership roles.*

As you've been reading this chapter and been on this journey with me, you may have realized that, just like when I entered Bennett College and didn't know what I wanted to major in, my various faculty positions also seem to indicate that I do not know what I want to do when I grow up :-). When I came to NCSU, I wanted to become a superb teacher/professor while teaching a 3–3–1 load (fall-spring-summer), continue being an active collaborative researcher, and also delve into statistics education research, while I still remained the ENAR Diversity Workshop co-chair and a member of the ASA CoMiS member on the StatFest planning committee. I remember walking into the office of my colleague Dr. Jacqueline M. Hughes-Oliver, feeling a bit frustrated because I couldn't seem to accomplish everything that I intended. Jackie said to me, 'Renee', you can do everything you want to do, but not at the same time!'

**Highlight Lesson 16** Often those who will be good leaders have many talents and interests. Do not try to stifle them or reign them in, work with them to *help them organize and achieve goals one at a time.* The creativity and ideas they have are often keys to them becoming diverse, inclusive leaders as their creativity and ideas

often make them better at being open to the creativity and ideas of others, as well as to the constructive feedback that others can provide on their ideas and leadership styles.

To date, I have had the honor of serving on several data safety and monitoring boards (DSMB) for the NIH and PCORI, as well as on expert panels for the Office of Women's Health and on external review panels for the Office of Biostatistics Research for the NIH National Heart, Lung, and Blood Institute (NHLBI). These leadership roles emerged out of my experience as the junior faculty member working in the data coordinating center (DCC) for a multisite childhood sleep apnea clinical trial (CHAT). Dr. Susan Ellenberg, who in 2019 gave the first COPSS (Committee of Presidents of Statistical Societies) Florence Nightingale David lecture, was PI of the DCC. While working as a graduate student in the BCC, Kirk identified my potential as a leader, and in my recommendation letters, he indicated that I have strong potential to lead DCCs. With this recommendation and a successful interview, Susan welcomed me to the CHAT DCC and took me under her wing.

The grant was funded around July, and my faculty position began in September. My first task was to conduct a power analysis for the secondary outcomes. This seemed straightforward enough until I considered that the trial had five different sites, each with investigator expertise from at least six domains (sleep, otolaryngology, neurocognitive, anthropometric, clinical/lab, and quality of life). I had to obtain preliminary data from all of them and help them come to a consensus on the top ten secondary outcomes. This first task immediately allowed me to interact with the scientific coordinating center PI, the PI at each site, and key coinvestigators across the sites. It also allowed me to work with Susan as well as another statistician at the scientific center. From day 1, Susan made me a part of the daily operations of this trial, and with each DSMB and steering committee meeting, she gave me a larger role, such that in the end, I led the analyses and presentations. Also, by the end of the CHAT study, Susan referred to me as the lead statistician, and she didn't just say it around me and the DCC, but also to the steering committee and NIH. Susan even asked NIH if I could be listed as the coPI of the DCC. They turned us down, as I was only 4 years past my Ph.D., but they did approve for me to be the interim PI during Susan's 3-month sabbatical. My contributions to the study were also publicly recognized with me being listed as the second author of the NEJM primary result manuscript, a huge deal given that so many contributed to the study (Marcus, Moore, . . . , Ellenberg, Redline, *NEJM* 2013). After we finished the study, whenever someone asked Susan to be on a DSMB and she could not accept the offer, she suggested me.

Four years after I left Penn, Susan and I were catching up in between sessions at the JSM. Amita saw us and jokingly said, 'Susan, are you trying to steal Reneé back to Penn?' Susan said, 'Reneé knows she has an open invitation.' Then Susan asked Amita, 'when is Emory going to nominate Reneé to be an ASA Fellow?' Amita answered, 'yes, Reneé has contributed so much to our profession.' I looked around, because I wondered which Reneé they were talking about. It turns out it was me! The next year, Amita led the nomination package for me, and Susan submitted a strong letter (which I still would love to read!) (Photo 3). I was inducted as a 2017

**Photo 3** Renee Moore, holding her 7-month old son, at the 2017 ASA Fellow Ceremony with DuBois Bowman and Dionne Price



ASA Fellow: “For contributions to the recruitment and mentoring of students in the profession, and especially outreach to underrepresented minorities; for highly valued collaborative work, especially in obesity and clinical trial research; and for outstanding teaching and increasing statistical literacy.”

**Highlight Lesson 17** *To create a leader, one must create opportunities for mentees.* Then, one needs to back them with strong and constant guidance, be an advocate for them, and continue to mentor them no matter how far they travel. When no longer at your institute, they are still creating a culture in the profession. They are showing that inclusive, diverse, and humanistic environments are the only viable environments. Amita Manatunga and Susan Ellenberg did this for me as a graduate student and first-time faculty member. They have their door open to me for guidance and mentorship still to this day.

At Penn, I wore two main hats. One was working in the DCC with Susan. The other was with my secondary appointment in the Department of Psychiatry as the faculty biostatistician in the Center for Weight and Eating Disorders (CWED). There, I was lucky that a senior biostatistician, Mr. Jesse Chittams, was available to be on the statistics team with me. I was a fresh graduate, and Jesse had over 10 years of experience as an academic biostatistician, who also had leadership roles in

creating and sustaining biostatistics consulting centers. We were able to dive into the world of the prevention, treatment, and management of obesity and eating disorders and contribute to observational studies as well as clinical trials. For one multisite U01 clinical trial (Penn PI Dr. Tom Wadden), Jesse and I were able to collaborate with the late Dr. Tom Ten Have as the senior faculty biostatistician at Penn, Dr. Tom Louis at Johns Hopkins University, and Dr. Bernard Rosner at Harvard University. I was a bit star struck, but Jesse kept me level-headed and encouraged me, saying that, even though I was junior, I too could make meaningful contributions. And we did! (Wadden, . . . , Chittams, Moore. A 2-year randomized trial of obesity treatment in primary care practice. *NEJM* 2011).

The lessons Jesse taught me about being a biostatistician immersed in a collaborative group were invaluable. I know my contributions to CWED would not have been as productive and rewarding without Jesse. However, in the early days, what resonated the most about Jesse was that he always had interns on his team, and it seemed like every few months there was a new intern in our statistics meetings and in meetings with our collaborators. Often, these interns had little to no experience in statistics, but Jesse described them to me as “diamonds in the rough” and indicated that we were providing the training for these intelligent, highly motivated students so that they could one day enter graduate schools and careers in the statistical sciences. Jesse found funding to pay them, and he dedicated endless amounts of time to training them. [For example, fast forward to a few years ago, I was able to onboard one of Jesse’s interns after he completed his master’s degree. In trying to decide how often we should meet, I asked how often he met with Jesse, and his response was, ‘daily’. I was in shock. I knew I would fall short of that type of close mentorship.]

In addition to his rotating interns who collaborated with us on CWED projects, Jesse also created and secured funding for the Diversity Initiatives in Research for Underrepresented Minorities (DRUM) Program. I was able to serve as a faculty advisor for high-school students in the DRUM program. Jesse has been a coinvestigator for several projects that answered ASA’s call to develop proposals for “Developing the Next Generation of Statisticians”, including the BRAIN (Biostatistics and Research Awareness Initiatives Network, Inc.) program for Ohio high school students directed by Lillian Prince. More recently, Jesse’s proposal for the Data Science Initiative Targeting High Schools (DSITHS) program was funded for recruitment in the Philadelphia area. His training programs are not just a conceptual introduction, he has interns engage in hands on exercises in SAS, REDcap, Qualtrics, etc., and his work with students often also involves conducting qualitative research to assess students’ knowledge, attitudes, and beliefs regarding the field of statistics. As a member of the ASA CoMiS and a past chair, as part of the ASA President Jessica Utt’s Careers for High School Students Working Group, through collaborating with PASTA (Philadelphia Area Statistical Teachers Association) and grant funded projects such as DRUM, DSITH, and in his daily work, Jesse has always made it a point to introduce statistics to those who have little exposure and provide them with skills to grow their interest and capacity in statistics.

**Highlight Lesson 18** *Creating an environment filled with the next generation of diverse leaders does not have to be an extra, it can be an inclusive part of your daily work and institution.*

I have been fortunate to have mentors who believed in me, pushed me, and always reached out. Though I've run out of time and space to share more stories, I would like to end this chapter by including a few more who have influenced my journey and helped shape me into the person, professional, and leader that I am today.

Dr. Nagambal Shah is a professor emeritus at Spelman College. She is the founder of the StatFest conference and a cofounder of the Infinite Possibilities Conference, a national conference that is designed to promote, educate, encourage, and support women of color interested in mathematics and statistics. Dr. Shah is an unsung hero at Spelman College and in the statistics community. She worked tirelessly behind the scenes to lead many women and men to careers in statistics. I recall first meeting Dr. Shah at a StatFest conference when I was in graduate school. After that, she and Sastry Pantula, who I also met there, always made it a point to reach out to me, see how I was doing, and offer any resources and support that they could. I recall Dr. Shah being at JSM meetings handing out flyers to those of us passing by to invite us to the ASA Committee on Minorities in Statistics (CoMiS) business meeting. I recall when I was named an ASA Fellow, Dr. Shah made sure that each person we passed knew of the achievement and that I was highlighted at the ASA CoMiS business meeting that year. Dr. Shah humbly works behind the scenes, often with no public recognition, and her work and passion have positively influenced the lives of most of us who are underrepresented and have earned degrees in statistics. Dr. Shah says her reward is watching all of us grow.

**Highlight Lesson 19** *Mentoring is often a thankless position. We pour time, emotion, and energy into our mentees, and the reward is watching them grow into humanistic, diverse, and inclusive professionals and leaders.*

Dr. DuBois Bowman, currently dean of the *University of Michigan School of Public Health* and a past ENAR president, arrived in his first faculty position at Emory during my second year as a graduate student. He was on my dissertation committee and helped me think through my job offers and negotiate terms. He was a mentor to me as I cochaired the ENAR Diversity Workshop. As he has moved from faculty member to founding director of a center, to a chair, and now to a dean, he always makes time for me when I reach out for his insight and advice. Despite the demands of his schedule, DuBois also always makes time to attend the ENAR Diversity Workshop and the ASA CoMiS JSM Diversity Mentoring Program.

**Highlight Lesson 20** *Despite the demands on our time as we become leaders, we must make time for the mentees who are also on the leadership trajectory. We must share our diverse, inclusive, and humanistic leadership experiences and insight to help others create the same type of leaders and environment.*

The work of creating diverse, inclusive, and humanistic leaders and environments is far from easy. It's actually really hard and time-consuming. However, the rewards far outweigh the difficulty. There is no greater accomplishment than training the next generation and creating a diverse, inclusive environment where all are welcomed



to share and where all contributions are valued. Another important aspect of this work is that *the transformation to a diverse, inclusive environment does not happen overnight; it does not happen in a year*. After attending one or two ENAR Diversity Workshops or StatFest meetings, some have come to me and said, ‘we still didn’t get any applications from underrepresented students or interns.’ My response is, ‘you are one person, and we are getting to know you. Students and mentors, like myself, must know that the environment in your department or your institution has both the entry criteria and the retention plan for diverse students to emerge successfully. We don’t know that if we’ve only met you one or two times. Keep hanging around, and you’ll see the applications come in.’

I started my journey in this chapter with seeds planted by Dr. Treadway when I was as a freshman in college. Dr. Shah each semester through her Calculus 1 course would identify students who had the potential to be statistics majors. MMUF recruits sophomores in college and supports them for 7 years to the doctorate degree and then also has programs to support early professors to promotion/tenure. Champions of increasing the pipeline of diverse mathematical and statistical sciences, like Jesse Chittams, invite high-school students to be a part of their daily work. None of these scenarios result in immediate change or leaders emerging overnight.

Typically, only one doctoral student a year worked in BCC prior to Dr. Christina Mehta (the Associate Director of BCC and chair of our department’s Diversity, Inclusion, and Equity committee) providing leadership to the BCC and prior to me directing it. We transformed the BCC such that nearly 15 master’s and doctoral students now work in the BCC. Faculties at Emory and beyond congratulate us. They often ask, ‘wouldn’t it be easier to do it yourself?’ Our response is, ‘yes, it would have been faster for me to do this myself, and yes, the students usually have to take breaks from BCC projects during midterms and finals, and so we must plan carefully. But I choose to train students so that they are better prepared when they leave our walls.’ Christina and I also do not let students work alone with investigators. We explain to our collaborators that the student may be doing the heavy lifting, but we are working closely with them at each step of the data cleaning, analysis, etc.

**Highlight Lesson 21** In order to create an inclusive, diverse, and humanistic environment, *institutions and people must make investments* of time, energy, and resources. They must recognize that *often these investments will not reach their full fruition for many years to come*. However, without these investments, we will not be able to create inclusive, diverse, and humanistic leaders and environments.

### **Summary: How Can Educators or Supervisors Build a Diverse, Inclusive, and Humanistic Environment?**

1. Plant seeds early, identify potential leaders early, and set goals early.
2. Reach back to young people before high school, and incorporate families in conversations about schoolwork and careers.

3. Meet students or workers where they are, retain them, and make sure that all exit your school or work programs with the same skill set.
4. Make sure the entry criteria for your programs or positions are diverse enough to welcome and retain a diverse student or work population.
5. Stretch every student or worker to help them reach their full potential.
6. Encourage students and workers to gain as many experiences as possible, and so they can find their passion.
7. Fully engage, encourage, and prepare emerging leaders so that you have successors who can continue the important inclusive and humanistic leadership work.
8. Support and provide the resources (e.g., time and financial) for team members to help support the goal of maintaining a diverse, inclusive, and humanistic environment.
9. Find the resources needed for a mentee or employee to attend an event that will help propel them to the next stage.
10. Create an open, comfortable environment where people can be themselves and offer ideas that may be different from the majority or status quo.
11. Value the uniqueness that each person brings to your environment.
12. Continue to fund and encourage important safe spaces (HBCUs, MMUF programs, BGSA groups, etc.) that provide for students who still often find themselves as the 'only one' in their environments.
13. Find a way to provide a diverse, humanistic, and supportive environment in your unit, while your organization catches up.
14. Support diversity of positions and values, finding the best fit for others, as inclusive leadership comes from diversity of perspectives and experiences.
15. Think outside of the box, and create and value positions that may be new or have not always been considered as leadership roles.
16. Emerging leaders have many talents and creative ideas and interests; help them to organize and achieve goals one at a time, and so they can, in turn, foster the creativity of others.
17. Create opportunities and advocate for mentees, and then back them with strong and constant guidance toward advancing an inclusive culture in the environment and the profession.
18. Make creating an environment filled with the next generation of diverse leaders an inclusive part of your daily work and institution.
19. Pour time, emotion, and energy into your mentees and watch them grow into humanistic, diverse, and inclusive professionals and leaders.
20. Share your diverse, inclusive, and humanistic leadership experiences and insights to help others create the same type of leaders and environment.
21. Realize that your investments of time, energy, and resources often will only reach their full potential for many years to come.

**Part IX**  
**Leading the Profession**

# Why Statistics Needs Thought Leaders and How You Can Become One



Jessica Utts and Barbara Goretsky

**Abstract** It is increasingly important for statisticians to act as *thought leaders*. Statisticians as team members can see the big picture and can impact all aspects of a project. As thought leaders, statisticians can influence data science ethics, integration of technical with nontechnical thinking, and proper communication of outcomes.

In the past decade, there has been concerted effort to encourage more statisticians to become leaders, whether in a formal or informal capacity. At least three recent presidents of the American Statistical Association (ASA) have had initiatives encouraging statisticians to become more involved in leadership activities, and ASA has provided tools to help them do so (LaVange, 2018; Rodriguez, 2012; Schenker, 2014). An excellent book titled “Leadership and Women in Statistics” published in 2016 includes 27 chapters filled with personal accounts and advice on leadership (Golbeck, Olkin, & Gel, 2016).

These efforts undoubtedly have had an impact by increasing awareness and resources for statisticians who aspire to formal leadership roles. But we predict that in the next decade, it will become increasingly important for statisticians to act in the more informal role of *thought leaders*. According to Amanda Golbeck, the editor of this volume:

*A thought leader* is a leader who generates informed and innovative ideas to advance a discipline. A *thought leader in science* is a technical expert who is highly regarded, called upon to provide advice, and invited to present and lead panels, edit books, and the like (Golbeck, 2018).

The coauthors of this chapter have been friends since high school and are collaborating on this chapter to provide the joint perspective of Jessica as a statistics

---

J. Utts (✉)

Department of Statistics, University of California, Irvine, CA, USA

e-mail: [jutts@uci.edu](mailto:jutts@uci.edu)

B. Goretsky

Aurora, CO, USA

© Springer Nature Switzerland AG 2021

A. L. Golbeck (ed.), *Leadership in Statistics and Data Science*,

[https://doi.org/10.1007/978-3-030-60060-0\\_25](https://doi.org/10.1007/978-3-030-60060-0_25)

371

professor and Barbara as a leadership development consultant. We provide some examples of thought leadership in statistics, including one that involves both Jessica and Barbara, and then discuss why statisticians need to become more active thought leaders. The examples in this chapter illustrate some techniques that will help you become a thought leader, and the final section will provide some additional advice based on Barbara's expertise in leadership development.

## Some Personal Examples

Throughout Jessica's career as a statistics professor and Barbara's career as a leadership development consultant, we have had occasions to act as thought leaders in our respective fields. Some examples from Jessica's career in statistics, mostly in response to invitations to write articles or give presentations, will help illustrate what thought leadership in statistics might look like and provide some clues to how to find opportunities and develop your skills in this area.

### *Example 1: The Early Days of Statistical Computing*

The first example (Utts, 1986) occurred early in my<sup>1</sup> career and early in the integration of computers into the daily work of academic statisticians. Personal computers (called "microcomputers" in those days) were just hitting the market at a cost of \$5000–10,000 each (in 1986 dollars; more than double that in 2019 dollars, when adjusted for inflation), workstations cost between \$20K and \$40K, and a "minicomputer" could be purchased for about \$100K. Statisticians and statistics departments were challenged with how to provide computing resources and support to faculty and with assessing what the impact of computers would be for the statistics discipline. Funding for the purchase of computing equipment for statistics departments first became available just a few years earlier, in 1982, from the National Science Foundation and the Department of Defense (Eddy, 1986).

It was in this context that a "Workshop on the Use of Computers in Statistical Research" was convened in 1985, with six participants. They were William Eddy (Chair), Peter Huber, Donald McClure, David Moore, Werner Stuetzle, and Ronald Thisted. The workshop was supported by a grant from the Office of Naval Research to the Institute of Mathematical Statistics (IMS) and had been planned and organized by the IMS Statistical Policy Committee, composed of Morris DeGroot (Chair), Donald Geman, Sam Greenhouse, Fred Mosteller, David Moore, Ingram Olkin, Ronald Pyke, and Jerome Sacks. We provide this level of detail, including the lists of names, to illustrate the importance of the topic at the time—many of the names

---

<sup>1</sup>Throughout the personal examples in this section "my" and "I" refer to Jessica.

listed were superstars in statistics research, education, and administration—and their participation probably indicates that they saw the issue of computers in statistical research as crucial to the future of the discipline.

One of the outcomes of the Workshop was a lead article in the newly established IMS journal *Statistical Science* (Eddy, 1986). That article was accompanied by seven invited discussion papers, and I was invited to write one of them. The invitation came from Morris DeGroot, who had chaired the Workshop planning committee. As someone new to the art of writing a discussion paper, I asked Morrie for advice, and he provided wisdom I have used numerous times since. When asked to write or present a discussion, he said, read the article and make some reference to it, but then talk about whatever you want! In other words, he gave me permission to turn my discussion paper into a “thought leader” paper if I so desired. I realized that it would be especially boring to just comment on the relatively technical main article, and so I decided to speculate on what the future of statistical computing might look like and to provide recommendations based on my speculation.

My dissertation work had been in the area of robust estimation and testing, and some of the more complex methods would not have been possible without computing. But I was concerned that as statistical methods and computers became more sophisticated, they would also evolve to more of a “black box” mystery for most users. So I focused my discussion paper on a hypothetical scenario 30–40 years in the future (i.e., about now) in which data are fed into a computer, out pops a nice result, and although no one knows what happened inside the “black box,” they all trust the results because they came from the computer. Unfortunately, we are seeing that scenario play out in some areas of machine learning, artificial intelligence, and even basic model selection! In my 1986 envisioned future scenario, statisticians had lost the battle for more cautious use of models and complex interpretations, because the subject-matter journals just wanted the computerized results, along with  $p$ -values and confidence intervals.

I made a series of recommendations in that paper, for statistics departments, university administrations, professional societies, research sponsors, and individual statisticians. To understand the focus of the recommendations, it’s important to know that most academic statisticians at that time were concentrated on mathematical and methodological research rather than on cross-disciplinary collaboration, which was mostly denigrated in tenure and promotion reviews. So my recommendations stressed the importance of statisticians getting more involved in cross-disciplinary work, if we were to avoid my envisioned scenario. I also recommended that statistics departments change the focus of their introductory courses to include more statistical literacy, noting that “We will not produce a statistically literate society by merely teaching the mechanics of computing means, standard deviations, and  $t$  tests. If the general principles are well understood, then it isn’t as dangerous to have the calculations done by the computer (Utts, 1986, p. 438).”

Focusing my recommendations on the need for more cross-disciplinary work and on promoting statistical literacy was a risky move for me and took some emotional courage. I was one of the few people in my department at the time who thought those activities were important and who incorporated them into my scholarly work.

Most of my department colleagues disparaged the time I spent on them and my efforts to promote them. Yet, this publication would be part of the material for my next academic review by the same colleagues.

I doubt if my recommendations were read by many people, much less followed. But I do know that they were prescient, and thankfully, today, the focus among many academic statisticians is on helping other disciplines understand the nuances of statistical modeling and interpretation. But we still have lots of work to do in helping ensure that statistical results are not misinterpreted by researchers, the media, and the public, and that's one reason we need more thought leaders in statistics!

### ***Example 2: Statistical Literacy***

When I was in graduate school, my mother was too. She was participating in a program sponsored by the State of New Jersey (her employer) to grant Masters of Social Work degrees to their social work administrators. The one course that terrified my mother was statistics, because she had had such a bad experience with it 30 years earlier when earning her B.A. degree in psychology. Fortunately, this time she had a wonderful experience, taking the course from Rutgers professor Harold Sackowitz, who focused on what social workers needed to know. It so happened that around the same time Barbara was pursuing a graduate degree in a liberal arts major. She, too, was required to take statistics, but she was not so fortunate, and I helped her struggle through a course that was completely formula-based, with no attempt at understanding the ideas.

The contrast in those two experiences, and the negative reaction of most people when I mentioned that I taught statistics, helped me realize that we needed to revamp the way we taught the introductory statistics course. I knew that statistics was useful and in fact quite important in navigating the world, but almost no one was conveying that message in the introductory course in the early 1980s. So I decided that once I had tenure I would write a textbook focusing on statistical literacy, eventually leading to the publication of my book *Seeing Through Statistics* (Utts, 1996), now in 4th edition (Utts, 2014). Barbara read the book and found it extremely helpful in her corporate role in thinking through how data can be used to tell a story and make decisions.

Once I had published the book, I started getting requests to talk about statistical literacy and was encouraged to write an article for *The American Statistician* (Utts, 2003). Titled "What educated citizens should know about statistics and probability," that paper has become a useful tool for acquainting nonstatisticians with important statistical ideas, and I'm often told that it's required reading for students in other disciplines. I continue to update my list of important topics and present them in talks when I have the chance. I'm thankful that the statistics education community has embraced the notion that statistical literacy is important. But there are many teachers of statistics who have not, and we still have work to do in getting the word out

about the importance of teaching concepts and understanding rather than focusing on formulas.

One lesson to be learned from the statistical literacy example is the importance of pursuing your passion if you are to be a thought leader. You won't be motivated to think outside the box unless you are invested in creating a change that you think makes the world a better place. That was my mindset in pushing for reform in the introductory statistics course.

### ***Example 3: Data Science Ethics***

When I was the president of the American Statistical Association in 2016, I was invited to participate in a 3-year National Academies of Sciences “Round Table on Data Science Postsecondary Education.” There were four meetings in each of the years 2017–2019, with focus on a different topic each time. (See [http://sites.nationalacademies.org/deps/bmsa/deps\\_180066](http://sites.nationalacademies.org/deps/bmsa/deps_180066) for details.) Two of the meetings opened my eyes to the importance of ethical issues in statistics, machine learning, and artificial intelligence. One was titled “Motivating Data Science Education through Social Good” (see [http://sites.nationalacademies.org/DEPS/BMSA/DEPS\\_189279](http://sites.nationalacademies.org/DEPS/BMSA/DEPS_189279) for the agenda and talks), and the other was titled “Integrating Ethical and Privacy Concerns into Data Science Education” (see [http://sites.nationalacademies.org/DEPS/BMSA/DEPS\\_178021](http://sites.nationalacademies.org/DEPS/BMSA/DEPS_178021)). As a result, I started reading books and articles on data science ethics. I endowed a scholarship on data science for social good, and I started working with an undergraduate student who wanted to do an independent study course, choosing the topic of data science ethics.

I was appalled by some of the abuses I read about in two books, *Weapons of Math Destruction: How Big Data Increases Inequality and Threatens Democracy* by Cathy O’Neil (2017), and *Hello World: Being Human in the Age of Algorithms* by Hannah Fry (2018). Both books discussed ethical problems with some of the current machine learning and artificial intelligence algorithms and applications and made me aware that we are not doing enough to educate our statistics graduate students about ethics.

Around the time I was starting my exploration of data science ethics, I was invited to give the President’s Keynote Address at the World Statistics Congress of the International Statistical Institute in Kuala Lumpur, Malaysia. The meeting was still many months away when I was required to choose a topic. So I decided I would have time to learn more and titled the talk “Enhancing Data Science Ethics Through Statistical Education and Practice.” I started reading more and asking many statisticians what first came to mind when they heard the phrase “data science ethics.” Most of them responded with topics related to data privacy, which certainly is one aspect of the problem. But there is so much more room for statisticians to contribute to the discussion of ethics, including issues related to study design, implementation, and ethical reporting of results to both scientists and the public.



In my invited address, I focused on what statisticians can contribute to data science ethics, how we should be doing more to raise awareness of the topic when educating our graduate students, and how statistical literacy at all education levels is part of our ethical responsibility. I plan to continue writing and speaking about data science ethics and encouraging other statisticians to get involved in the discussion. This example reiterates the importance of pursuing topics you are passionate about if you want to be a thought leader.

## Examples of Thought Leaders in Statistics

### *John Tukey*

If anyone had made even half of the intellectual contributions made to statistics, computer science, and applied disciplines by John Tukey, they would have gone down in history as an influential thought leader. Tukey's many contributions included simple ideas like the box plot and stem-and-leaf plot and complex ideas like projection pursuit (joint with Jerome Friedman) and Tukey's range test for multiple comparisons. He invented the term "bit" as a contraction of "binary digit," and according to his obituary in *The New York Times* (Leonhardt, 2000), he was the first to publish the term "software" when in 1958, he wrote "Today the 'software' comprising the carefully planned interpretive routines, compilers, and other aspects of automative programming is at least as important to the modern electronic calculator as its 'hardware' of tubes, transistors, wires, tapes, and the like (Tukey, 1958)."

Tukey also raised awareness of the difference between exploratory and confirmatory data analyses with his groundbreaking book *Exploratory Data Analysis* (Tukey, 1977). In 1973, Tukey was awarded the National Medal of Science by President Nixon. He was a member of the President's Scientific Advisory Committee for Dwight Eisenhower, John F. Kennedy, and Lyndon Johnson. Some of his many contributions are outlined by Karen Kafadar (2001) in a special issue of *Technometrics* dedicated to his memory and by David Brillinger (2002) in the *Notices of the American Mathematical Society*. Kafadar and Brillinger were two of Tukey's dozens of Ph.D. students.

How did John Tukey become such an influential thought leader? One can only speculate, but perhaps it's because he was educated at home by his parents, and according to McCullagh (2003), "Their educational method was to respond to John's queries by providing clues and asking further questions rather than giving a direct answer, a characteristic that John inherited and used throughout his career." Whatever the reason, John Tukey illustrates one of the main skills of a thought leader—integrated thinking that connects the dots from seemingly disjoint topics, resulting in visionary ideas that seem obvious only in retrospect.

## ***Elizabeth Scott***

Academic women owe a debt of gratitude to Elizabeth Scott for her pioneering work in studying gender equity in academic salaries. Scott was passionate about causes related to social justice, and she recognized that these causes often could be advanced by acquiring data and applying appropriate statistical methods. Her most famous legacy in this regard is the creation of the AAUP Higher Education Salary Evaluation Kit (Scott, 1979). The kit consisted of instructions for using regression analysis to evaluate salary inequities and was distributed by the American Association of University Professors (AAUP). Hundreds of colleges and universities used it, and many have institutionalized the study of faculty salaries in order to flag inequities if they occur.

One of the reasons Scott was so effective in advancing her causes is that she excelled at networking and communicating across boundaries. She created a network of colleagues at UC Berkeley that included all levels, from graduate students to the highest administrators. She did the same thing nationally, within the statistics community, other academic disciplines, and outside of academia. She communicated with members of Congress to advocate for legislation to promote women in science. She advocated for causes she believed in, and when possible, she incorporated data into her advocacy.

In her excellent book *Equivalence: Elizabeth L. Scott at Berkeley*, Amanda Golbeck (2017) tells the story of Scott's life through a meticulous study of her letters and archives. An abbreviated description of Scott's leadership skills is included in Golbeck's chapter in the book *Leadership and Women in Statistics* (Golbeck et al., 2016), in which she lists eight basic principles that made Elizabeth Scott an effective leader. The list is reproduced here (without the accompanying explanations) because, although some of it is specific to Professor Scott's activities, much of the list has direct relevance for anyone aspiring to be a statistics thought leader (Golbeck, 2016, p. 48–49):

1. Collaborate toward positive action.
2. Make evidence-based recommendations.
3. Use statistical methods.
4. Be precise and accurate.
5. Use channels.
6. Work hard and persevere.
7. Keep monitoring.
8. Involve men.

We would add just one additional principle exemplified by Elizabeth Scott as a thought leader: Have the emotional courage to take risks in pursuing your passion.

## *Allan Rossman*

There are many bloggers writing about statistical topics, and many of them would qualify as thought leaders. Here, we focus on one, Allan Rossman, who has initiated a blog for statistics educators, especially for the introductory course. Rossman is a professor at Cal Poly San Luis Obispo and internationally recognized for his contributions to statistics education. For many years, he has advocated for his simple mantra: Ask good questions. Fittingly, he started a blog with that title, <https://askgoodquestions.blog/>. The simple description of the blog reads “This weekly blog provides ideas, examples, activities, assessments, and advice for teaching introductory statistics, all based on a three-word teaching philosophy: Ask good questions.”

Long before starting his blog in July 2019, Rossman had collaborated with Beth Chance to create a series of extremely useful applets for helping students understand statistics and probability (<http://www.rossmanchance.com/applets/>). Rossman and Chance also collaborated on the books *Workshop Statistics: Discovery with Data* to encourage instructors and students to teach using a hands-on approach. These innovative teaching and learning tools have benefited thousands of students in advancing their understanding of statistical concepts.

Another example of Rossman’s innovative thinking was his choice of topics for a session at the 2019 Joint Statistical Meetings. The session included talks by six winners of the Waller Education Award, and they were invited to talk on any statistics education topic of their choosing. Rossman’s title was “Recognizing Human Progress” and the abstract read:

Hans Rosling and his colleagues have asked thousands of people: In the last 20 years, has the proportion of the world’s population living in extreme poverty doubled, remained about the same, or been cut in half? Rosling mentions that in every country, less than 25% answer correctly, and only 5% answer correctly in the U.S. Steven Pinker has argued that “the world has made spectacular progress in every single measure of human well-being” and also that “almost no one knows about it.” In this talk I suggest that statistics teachers can make a positive impact by introducing students to such data and making them aware of cognitive biases that prevent people from recognizing progress. (<https://ww2.amstat.org/meetings/jsm/2019/onlineprogram/AbstractDetails.cfm?abstractid=300308>, accessed October 8, 2019)

The talk was an eye opener for a few reasons. First, the data presented were counterintuitive, as is obvious by reading the abstract, and the examples used illustrated that human well-being is in much better shape than most people think. And second, the talk advocated for teaching statistics using uplifting topics and data, in stark contrast to the examples often used in teaching.

The above examples illustrate that Rossman fits the definition of a thought leader presented at the start of this discussion, as “a leader who generates informed and innovative ideas to advance a discipline;” in this case, how and what we teach in introductory statistics courses.

## The Increasing Importance of Thought Leaders in Statistics

In the old days, a statistician's job was fairly simple. We designed studies and analyzed data based on relatively small numbers. We helped our employers, or collaborators, or clients understand the models and interpret the results. Our students got jobs in academia, or in government or industry, with a clearly defined role as statistician. But as sources of data become more plentiful, massive datasets are easy to acquire, and machine learning methods create more of a black box approach to data analysis, statisticians are more likely to be one member of a larger team—none of whom is fully in charge of the analysis and interpretation of results. That creates an opportunity; in fact, some might say an obligation, for statisticians to engage in more integrative and “big picture” thinking.

In the science fiction novel *Stranger in a Strange Land* (Heinlein, 1961), there is a fictional occupation called “fair witness.” Fair witnesses are trained to be perfect observers, and their word in a court of law is taken as truth above anything else. The term has become part of common culture and is sometimes cited as something for a leader to aspire to achieve (e.g., Andersen, 2012). As noted by Wikipedia (2019), “Works that refer to the Fair Witness emphasize the profession's impartiality, integrity, objectivity, and reliability.” What better description is there for an ethical statistician?

One role we envision for a statistician as thought leader is seeing the big picture of a project and sharing it with others. This would include thinking about ethical implications, understanding the importance of knowing the source of the data in making conclusions, providing guidance on how to report results, envisioning what needs to be done next, and generally guiding the team toward a holistic view of the project and where it fits with the greater mission of the company or research team.

Beyond individual projects, we envision statisticians as thought leaders to help determine the future directions of data science. Circling back to Jessica's 1986 hypothetical scenario, it's important for statisticians to make sure machine learning and artificial intelligence don't replace human intelligence. Statisticians understand that uncertainty will always accompany results of any algorithm and that the individual is not the same as the aggregate. We need to make sure others understand these issues too. In 1994, John Tukey was on a panel at the Joint Statistical Meetings and was asked “In your opinion, what has been . . . the greatest failure, in statistics?” Tukey answered that “Our greatest failure has been our inability to communicate the notion of uncertainty to the layperson (Kafadar, 2001).” As statisticians, we need innovative ways to communicate the importance of our basic principles to both laypeople and other scientists, especially as research projects become more complex.

In her October 2019 ASA President's Column in *Amstat News*, Karen Kafadar (2019) wrote “The world's challenges may give us opportunities that will lead to good times for statisticians. We will have to work together to make that happen.” Let's get started!

## **How to Be a Thought Leader**

Hopefully, we have convinced you that becoming a thought leader is a good idea. But how do you do it? As a professional who has spent her entire career developing leaders, Barbara has found a few principles that have withstood the test of time (and research). Here are some practical steps:

### ***Build a Niche Area of Expertise***

Determine what you are passionate about. Ask yourself: where do your interests lie? What topics are you drawn to? What do you continue to want to learn more about? What are the values you are passionate about? Many people never think about their values in relationship to their passions; yet, values exemplify who we are as leaders and how we behave. They also guide ethical considerations regarding data analysis. You probably won't become a thought leader in an area for which you have no passion because of the energy and commitment it takes to build the expertise.

Next, determine what skills you have in this particular area. Be honest with your self-assessment with the understanding that you may be very interested in a specific topic but not very skilled at it. Understanding your limitations can help focus you on those areas of skill and passion. Where do they intersect? Elizabeth Scott provided a good example when she realized that her statistical skills could help with her passion for achieving gender equality in academia. Jessica's passion about problems with data science ethics led her to start reading vociferously on that topic and to start speaking and writing about it. Barbara has been passionate about developing leaders since writing her Master's Thesis on the subject. This niche area could become your "brand," thus identifying you as an expert in this area.

### ***Have a Point of View About Your Area of Expertise***

As you learn more about your area of interest, develop your own ideas about the topic and communicate those. Think about where you would like to see things in that area in the future. Don't be afraid to express your point of view, even in the face of dissent. Allan Rossman provided a good example by repeatedly stressing his mantra of "ask good questions" and then developing tools to help the statistics education community incorporate that theme in their work. Jessica's passion for having a statistically literate society led her to encourage others to teach introductory statistics with a focus on literacy. Barbara's passion for developing leaders enabled her to create executive development programs for Fortune 100 companies.

### ***Build Competence and Credibility in Your Area of Interest***

It goes without saying that you need to have competence in your area of interest, but you also need to let others know about your competence. The ultimate objective is to be known as an expert. You can do this by writing articles, blogs, and tweets, by giving talks, and by networking with others who either share your interest or can benefit from it. For instance, if there is an ASA section related to your interest, join the section and volunteer to run for office. Or attend the annual section meeting and network with others.

### ***Become an Integrative Thinker, Connecting the Dots Among Different Ideas***

Some people are naturally good at integrative thinking, but anyone can learn how to do it. First, expand your horizons beyond the statistics profession. The world today needs diversity of ideas from all fields if we are going to continue to innovate. The field of statistics is changing, and you need to change with it. You may find yourself becoming a thought leader in a totally different field, with the application of your expertise. Read widely, especially nontechnical material such as *Significance Magazine* or *Amstat News*. Think about how topics you read about are related to your area of expertise and how you may be able to apply new thinking to these topics. For instance, if you read about interactive activities for the classroom but you are a nonacademic working with a research team, think about how the same principles could help you explain statistical ideas to the other members of your team.

The best way to become an integrative thinker is to ask questions, and questions asked out of curiosity and a willingness to learn are the best questions to ask. For example, ask “what if” questions. These can spark a different perspective to a seemingly mundane topic. Ask questions from a different perspective, such as “how would a skeptic look at this?” or “what would a competitor say to try to discredit our work?” Discuss your work with others who are not experts and have them ask you questions about it. John Tukey demonstrated integrative thinking in much of his work, for instance, in his ability to create simple graphical techniques such as stem-and-leaf plots to illustrate multiple statistical concepts.

### ***Be Willing to Take Risks and Develop Emotional Courage***

You won't know how others react to your ideas until you put them out there. Be willing to take a risk, and if you are working in a controversial area, expect some resistance. Realize that criticism is directed at your topic, not at you. Many of us

are risk-averse because we have been trained to be accurate and precise. It may be difficult to go out on a limb and put a controversial idea forward. It may not be accepted; it may be scorned, but if you are a confident risk-taker, you will feel comfortable with the criticism. If Elizabeth Scott had been intimidated by those who thought there were no problems of gender equity in academia, she would not have been effective in creating change. Golbeck (2017) provides multiple examples of how Scott responded to her critics with facts and with grace under fire.

### ***Learn How to Communicate with Both Technical and Nontechnical Audiences***

As journalists know, storytelling is the most effective tool for engaging people who are not experts in your subject. Research shows that audiences will remember numbers presented with a story more often than the numbers presented alone. Even if you are trying to communicate a technical idea, start with a story. For example, in Jessica's presentation on data science ethics, she wanted to make the point that statistics students should be taught to consider the ethical implications of their work in all situations. When they join the workforce and are given an assignment, they should learn to ask "why" before asking "how." But just telling statistics educators that they should include a discussion of ethics in all of their classes would not be as effective as telling the following story, told to Jessica by a student long ago. An engineering professor assigned an in-class exercise for students to design a pipeline to send blood from a developing country to a richer, developed country. Students got to work, figuring out the best diameter for the pipe, how to get it to go through a body of water, how to keep the temperature and humidity constant to keep the blood fresh, and so on. After allowing this discussion to continue for a while, the professor asked the class why no one had questioned the ethics of the assignment. The students' response? "This is a class in engineering, not in ethics!"

In one of Allan Rossman's blog entries, he provides an example of communicating a technical point to a nontechnical audience, in this case, students taking an introductory statistics course who are not statistics majors. He wants to convey the importance of getting a representative sample to avoid bias in statistical inference. So he tells the following story (modified slightly by Jo Hardin, another statistics thought leader, to include the idea that gender is self-identified): "Assume that an alien has landed on Earth and wants to understand the gender diversity of humans. Fortunately, the alien took a good statistics course on its home planet, and so it knows to take a sample of human beings and produce a confidence interval for this proportion. Unfortunately, the alien happens upon the 2019 US Senate as its sample of human beings. The US Senate has 25 senators who self-identify as having a female gender (its most ever!) among its 100 members in 2019." Of course, we earthlings know that this was a biased sample, but how was the alien to know?

You can make your message memorable through storytelling, whether you are communicating to a technical or a nontechnical audience.

### ***Network, Network, Network***

Expand your network beyond the obvious. When Jessica was an assistant professor at the University of California, Davis the women faculty started a group called “the women faculty research support group,” which met monthly in someone’s home. The meetings centered around hearing about the research of one of women faculty members, presented in a nontechnical format. But the larger purpose was to get to know each other. The connections established through that group continue to be valuable 40 years later. Throughout Jessica’s career on that campus, if she had a question about something related to a different subject she knew someone she could call and ask. Or if she needed to know more about the actions of a certain committee, she could find someone she knew on the committee. Or when she was serving in an administrative role on campus, she could get information from a variety of colleagues across campus.

Another excellent mechanism for networking is professional societies like ASA. There are local chapters, sections based on statistical interests, and various committees, all of which are usually looking for volunteers to serve in leadership roles. Make it known to the leadership if you want to volunteer to run for office or be appointed to a committee. Most statisticians who have served in higher leadership roles such as ASA president got their leadership start in local chapters or ASA sections.

### ***Expand Your Horizons***

At times, work requires our attention 24/7, leaving little time for other activities and interests. Having balance in life means poking your head up from work occasionally and taking a step back to learn what else is happening in the world. Take time to explore new hobbies or take trips or get involved in your community. Meet new people outside of the statistics field and learn more about their areas of expertise. Reach out to colleagues in other disciplines and learn their perspectives. For example, if you are an academic statistician, learn who else on campus is teaching or doing statistics and invite a group to lunch to discuss teaching ideas. If you work for another type of organization, figure out who else in the organization might be interested in discussion topics of common interest and start a discussion group. Read widely, not just in your own area of interest. Go to presentations outside your department that are related to your interests.



## *Be a Positive Influence*

No one likes to be dragged down by pessimism. Think about how you can make a difference and be optimistic that it can happen. As Margaret Mead is alleged to have said, “Never doubt that a small group of thoughtful, committed citizens can change the world; indeed, it’s the only thing that ever has.” (This quote is often attributed to Mead, but no original source has been found.) Be inspiring!

Will following these steps help you become a recognized thought leader in statistics? We both hope so. Putting the requisite time and attention into developing these skills can lead to undreamed of possibilities and, as a side benefit, can be lots of fun! We wish you the very best in your endeavors.

## References

- Andersen, E. (2012). *Leading so people will follow*. San Francisco, CA: Jossey-Bass. ISBN 978-1118379875.
- Brillinger, D. R. (2002). John Wilder Tukey (1915–2000). *Notices of the American Mathematical Society*, 49(2), 193–201. Retrieved from <http://www.ams.org/notices/200202/fea-tukey.pdf>
- Eddy, W. F. (1986). Computers in statistical research. *Statistical Science*, 1(4), 419–437.
- Fry, H. (2018). *Hello world: Being human in the age of algorithms*. New York, NY: WW Norton & Company.
- Golbeck, A. L. (2016). Four leadership principles for statisticians: A note on Elizabeth L. Scott. In A. L. Golbeck, I. Olkin, & Y. R. Gel (Eds.), *Leadership and women in statistics*. Cleveland, OH: CRC Press.
- Golbeck, A. L. (2017). *Equivalence: Elizabeth L. Scott at Berkeley*. Cleveland, OH: CRC Press.
- Golbeck, A. L. (2018). Personal communication, Nov 21, 2018.
- Golbeck, A. L., Olkin, I., & Gel, Y. R. (Eds.). (2016). *Leadership and women in statistics*. Cleveland, OH: CRC Press.
- Heinlein, R. A. (1961). *Stranger in a strange land*. New York, NY: Putnam.
- Kafadar, K. (2001). In Memoriam: John Wilder Tukey June 16, 1915–July 26, 2000. *Technometrics*, 43(3), 251–255. Retrieved from <http://www.jstor.org/stable/1271211>
- Kafadar, K. (2019, October 1). On becoming indispensable. *Amstat News*. Retrieved from [https://magazine.amstat.org/blog/2019/10/01/kk\\_oct2019/](https://magazine.amstat.org/blog/2019/10/01/kk_oct2019/).
- LaVange, L. (2018, February 1). Lead with statistics! *Amstat News*. Retrieved from <https://magazine.amstat.org/blog/2018/02/01/leadwithstatistics/>.
- Leonhardt, D. (2000, July 28). John Tukey, 85, Statistician; Coined the word ‘Software’ (p. A19). *The New York Times*. Retrieved from <https://www.nytimes.com/2000/07/28/us/john-tukey-85-statistician-coined-the-word-software.html>.
- McCullagh, P. (2003). John Wilder Tukey. *Biographical Memoirs of Fellows of the Royal Society*, 49, 538–559.
- O’Neil, C. (2017). *Weapons of math destruction: How big data increases inequality and threatens democracy*. New York, NY: Broadway Books.
- Rodriguez, R. (2012, February 1). Statistical leadership: Preparing our future leaders. *Amstat News*. Retrieved from <https://magazine.amstat.org/blog/2012/02/01/statisticalleadership/>.
- Schenker, N. (2014, May 1). Developing training in statistical leadership. *Amstat News*. Retrieved from <https://magazine.amstat.org/blog/2014/05/01/pres-corner-may14/>.
- Scott, E. L. (1979). *Higher education salary evaluation kit*. American Association of University Professors: Washington, DC.

- Tukey, J. W. (1958). The teaching of concrete mathematics. *The American Mathematical Monthly*, 65(1), 1–9.
- Tukey, J. W. (1977). *Exploratory data analysis*. Boston, MA: Addison-Wesley.
- Utts, J. (1986). [Computers in statistical research]: Comment. *Statistical Science*, 1(4), 437–439.
- Utts, J. (1996). *Seeing through statistics*. Pacific Grove, CA: Duxbury Press.
- Utts, J. (2003). What educated citizens should know about statistics and probability. *The American Statistician*, 57(2), 74–79.
- Utts, J. (2014). *Seeing through statistics* (4th ed.). Boston, MA: Cengage Learning.
- Wikipedia Contributors. (2019). Stranger in a strange land. In *Wikipedia, the free encyclopedia*. San Francisco, CA: Wikipedia Foundation. Retrieved October 8, 2019, from [https://en.wikipedia.org/w/index.php?title=Stranger\\_in\\_a\\_Strange\\_Land&oldid=918031316](https://en.wikipedia.org/w/index.php?title=Stranger_in_a_Strange_Land&oldid=918031316)

# Leadership Across the Diversity of Statistics



Helen MacGillivray

**Abstract** Data Science has contributed to renewed emphasis on identity and leadership in the Statistical Sciences. Of critical importance are the nature and diversity of Statistics in all endeavours involving data, variation and uncertainty. Through discussion of leadership across the diversity and people of Statistics, this chapter also emphasises its development.

## Summary

Attention on data science, big data and data analytics has contributed to renewed emphasis on identity and leadership in the statistical sciences. General discussion of diversity and inclusivity has valuable messages, but an extra dimension of critical importance is the inherent natural diversity of the statistical sciences in their inextricable linkage to all endeavours involving data, variation and uncertainty. Within identification and discussion of leadership across the diversity and the people of statistics, this chapter also emphasises its development and promulgation. Inspirational leadership can involve connecting with giants; far and deep-sighted leadership; or connecting locally and personally. The key competencies for leadership in the good practice of statistics are also the characteristics of statistical leadership in teaching. This chapter gives examples of these and of providing foundations for leadership in future statisticians and their collaborators and clients across other disciplines, research and workplaces. After emphasising the importance of humanistic and inclusive leadership in professional statistical societies, and of broader outreach and communication by the whole statistical community, particularly with regard to data science, the chapter finishes with advice for leadership across the diversity of the statistical and data sciences, under seven signature traits, which can be practised by all.

---

H. MacGillivray (✉)  
Queensland University of Technology, Brisbane, QLD, Australia  
e-mail: [h.macgillivray@qut.edu.au](mailto:h.macgillivray@qut.edu.au)

## Introduction

The juxtaposition of ‘leadership’ and ‘diversity’ currently tends to lead a searcher to certain types of diversity. Diversity of leadership styles might feature, but currently the emphasis in ‘diversity’ tends to be oriented to personnel, backgrounds and talents, ideas, and, in the case of business, markets. This emphasis is as important in statistical organisations and workplaces in which statisticians work as for any profession, but an extra dimension in the statistical sciences lies in their very nature, which is inherently diverse and diffused. Understanding and considering this diversity and diffusion are essential in considering, building and promulgating leadership in statistics and statistical leadership.

Statistics is the science of variation, uncertainty and data: of learning from data; of interpreting and critically evaluating data-based information; of modelling data, variation and uncertainty and critiquing models. Statistics covers the full gamut of data-driven research and processes: from the design, collection, sourcing, handling and preparation of data, right through to the communication of information and critiquing, which lead to further researching in the broadest sense. The statistical sciences are inextricably linked to all endeavours involving data, variation and uncertainty across disciplines, business, industry, government, and society. Therein lies the extra dimension of diversity in the statistical sciences. Statistics both serves and leads developments in all other disciplines, including mathematics and data science, and, in its turn, is served and led by the needs of other disciplines. From the most theoretical to the most applied areas of the statistical sciences, there will be links to, and motivations from, real contexts and problems in at least one other discipline. Rodriguez (2013) describes statistics as the ‘most unselfish of sciences’; and that ‘Statistics improves human welfare not by its own ends, but by its contributions in all fields’.

This inherent diversity and diffusion are simultaneously the heart of the strength and vulnerability of the statistical sciences. The vulnerability lies in visibility and identity and is not new, but has recently received increased attention and commentary. Rodriguez (2015) asked ‘how do we resolve the paradox of a profession that is both invaluable and invisible?’ Wasserstein (2015) commented that increasing the visibility of our profession ‘is a challenge we have been facing for many years’, and discussed examples of both progress and non-progress. Gibson (2019) comments that resolving ‘the paradox requires statistical leadership, effective communication’ . . . ‘and increased partnership with other quantitative disciplines’. Geller (2011), emphasises communication, which is of critical importance across every aspect of the statistical sciences, but we must also take account of the natural diversity of statistics. This diversity also means that effective communication and sharing within the statistical community are as important as communication with other disciplines, government, business, industry and the broader community. Such communication is essential for statistical leadership, and requires respect across the whole statistical community.

No matter what type or aspect of leadership we contemplate, we must always consider how to develop leadership. In this chapter, in touching on different types of leadership across statistics—including inspirational, leadership in the practice of statistics, and people, hence humanistic and inclusive leadership,—the emphasis is always on how to develop leadership. This, perforce, involves considerable focus on statistics education and developmental learning, including challenges in statistics to sustaining innovations. As many examples as possible are used, with personal connections or stories. What becomes clear is that inclusivity and diversity are dimensions of true statistical leadership, and the chapter finishes with thoughts on how everyone can develop, and contribute to the development of, leadership across the diversity of statistics.

## **Some Different Types of Leadership Relevant to Statistics**

The types of leadership considered below are interdependent and intertwined. They are a convenient classification to facilitate comments and examples.

### ***Inspirational***

When one thinks ‘leadership’, one often thinks of leaders in, or of, the field or discipline. Associated with his comment on statistics’ contribution to human welfare, Rodriguez (2013) remarked that ‘Our profession has an extraordinary number of heroes’ and ‘Heroes are people who achieve great things in ways that encourage us in our own efforts to do great things’. Rodriguez referred to people who significantly advanced and led scientific, professional and/or educational developments across the diversity of statistics, all ‘warmly remembered for the personal interest they took in the work of others’.

Inspiration can be drawn from statistical giants in the field, but also from more local statistical ‘heroes’. Contact with those who have gone ahead but are not too far, and with whom we can identify or feel some affinity, can be inspiring along with stories from national and international leaders who may be more remote in time, space or achievements. In section “[Some Examples of Inspirational Leadership and Diversity of Statistics and People](#)”, I outline some examples of diverse statistical inspirations, including ways to help students be inspired and also to connect with leading developments.

## *Leadership in the Practice of Statistics and How to Develop It*

This constitutes the most and most far-reaching examples as it encompasses the heart of statistics across a great diversity, and hence also encompasses the enormous reach of statistical learning and teaching across all educational levels, and across disciplines. It has even been named recently (Gibson, 2019) as statistical leadership. Why and how teaching statistics, including to other disciplines, is, and contributes to developing, statistical leadership that is both diverse and inclusive, is discussed below and in section “[Some Examples of Teaching Leadership in the Practice of Statistics and How to Develop It](#)”.

Gibson (2019) focusses on statistical leadership in a collaborative environment as most important, describing it as ‘the use of influence to guide a multidisciplinary research team’, also commenting that a statistician can function as an individual leader, an enterprise leader, or a policy leader. The leadership described by Gibson is the ‘entwined collaboration’ of Cameron (2009) compared with the ‘serial collaboration’, which is closer to ‘straight consulting’ (Boen & Zahn, 1982). Gibson’s (2019) emphasis on active listening, asking questions, networking and communication reflect many publications on the diverse skills and personal attributes required to be a good ‘statistical consultant’ (for example, including Derr, 2000; Russell, 2001; Cabrera & McDougall, 2002; Kenett & Thyregod, 2006). Barnett (1976) describes statisticians as needing to be translators and communicators. In a long list of advice and skills needed, Joiner (2005) includes:

- Be able to listen carefully and ask probing questions.
- Be diplomatic and know when to bend, when to stand firm, and how to help smooth conflicts over among other team members.
- Be a good teacher—much success in consulting depends on being able to help others understand statistical tools, and their strengths and weaknesses.

As with Joiner’s list, all of the skills and attributes described by such authors are active elements of leadership; Gibson is advocating more explicit identification and acknowledgement of these as statistical leadership.

Gibson (2019) comments positively on the growth of training graduate students in the US within university statistical consulting centres, through internships for graduate students, and continued professional development. Absence of preparation for consulting has been previously lamented (for example, Kenett & Thyregod, 2006; Russell, 2001), but there have been excellent examples of courses in conjunction with statistical consulting centres as far back as Smyth (1990), in capstone courses (Smith & Walker, 2010), in preparing students for industry placements (Rangecroft & Wallace, 1998), and, most significantly, in earlier undergraduate years, using role play (Taplin, 2003, 2007) and community-based projects (Jersky, 2002; Thorne & Root, 2002).

Statistical leadership, as the use of influence to guide the work of a multidisciplinary team, is not restricted to research teams, but is appropriate in many contexts in business, industry, government, internationally, and, in particular, education

across school, tertiary and workplace. Despite decades of work across the world, in 2019 Gibson comments that ‘We miss the first opportunity to convey the value of statistics to an increasingly large number of non-statisticians enrolled in our service courses’. Examples are given here of this type of statistical leadership for service courses and in courses for statistics majors.

### *Leadership and People*

Leadership of people is embedded in, and intertwined with, both sections “[Inspirational](#)” and “[Leadership in the Practice of Statistics and How to Develop It](#)” above: in section “[Inspirational](#)” with inspiration and mentoring; in section “[Leadership in the Practice of Statistics and How to Develop It](#)” with leadership within teamwork and with mentoring, in both the good practice of statistics and the education to achieve. Leadership of professional organisations is also about people, because professional organisations are their members. In addition, leadership in professional organisations also contributes to the public face of the profession, including orientation and organisation of journals and conferences, which greatly contribute to how the profession is perceived and to development and progression of its people.

Because considering leadership across the diversity of statistics and how it is developed involves people in every way, it is worth gleaning at least something from the extensive literature and websites on humanistic and inclusive leadership, which tend to be focussed on hierarchical structures in organisations with paid employment, especially, but not limited to, business and industry. According to Nathanson (2017),

Humanistic leadership is about trusting others, being ethical, having compassion, and participating as a collective whole . . . . There should be a transparent communication and collaboration vs. internal competition among its members . . . . The key tenants of humanistic leadership are placing the needs of people over profit, to have empathy and respect for others.

Bourke and Dillon (2016) discuss diversity as ‘Diversity of (global) markets, customers, ideas, and talent: These simultaneous shifts are the new context’. For statistics, the first can be translated as diversity of needs and hence applications and methods, and the second generalised to diversity of statistical community, collaborators, clients and customers. They also identify ‘six signature traits’ of inclusive leadership, namely, cognisance, curiosity, cultural intelligence, collaboration, commitment and courage. Although framed in terms of commercial enterprises, these traits are particularly relevant to statistical leadership and its development in all its forms. The practice of them benefits the whole of statistics, and I refer to them in the final thoughts.

## Some Examples of Inspirational Leadership and Diversity of Statistics and People

### *Connecting with Giants*

The International Prize in Statistics (IPS) was established in 2015 by five leading statistical organisations: American Statistical Association (ASA), International Biometrics Society (IBS), Institute of Mathematical Statistics (IMS), International Statistical Institute (ISI), and Royal Statistical Society (RSS). As stated at <https://statprize.org/>,

the primary objective of the International Prize in Statistics is to call public attention to the important role statistics, data analysis, probability, and the understanding of uncertainty have played in the past and are playing today in the advancement of society, science, technology and human welfare, with a decided focus on current developments. Another leading objective is to identify penetrating and valuable insights and advances in statistics that can help achieve the primary objective.

The IPS is presented biennially at the ISI World Statistics Congress (WSC). The first two winners are statistical giants: Professor Sir David Cox (2017) and Professor Bradley Efron (2019), <https://statprize.org/previouswinners.cfm>. Both have received recognition from many and diverse sources of their extraordinary achievements, for example being joint winners in the Basic Sciences category of the 2016 BBVA Foundation Frontiers of Knowledge Awards, [https://en.wikipedia.org/wiki/BBVA\\_Foundation\\_Frontiers\\_of\\_Knowledge\\_Awards](https://en.wikipedia.org/wiki/BBVA_Foundation_Frontiers_of_Knowledge_Awards), demonstrating how great and widespread is statistical influence. Although the focus of the IPS is on ‘powerful and original ideas’, the lifeworks of these statistical giants are characterised also by the ability to see the big picture, to bring together concepts and to innovate across all of statistics. This was well demonstrated, and commented on by many, in Professor Efron’s plenary at the ISI WSC 2019, <https://statprize.org/pdfs/materials/2019Efron-presentation.pdf>.

The presentation to Professor Efron, and his plenary, also demonstrated the strong inclusive and humanistic leadership which has marked, and continues to mark, the ‘heroes’ of statistics. To Professor Efron’s great delight, his prize was presented by an all-female cast of the five IPS Foundation organisations’ Presidents and the Chair of the IPS Foundation, and the comments from the presenters demonstrated how important was his support of diverse people throughout his career. His acceptance speech, <https://statprize.org/pdfs/2019-Efron-AcceptanceSpeech.pdf>, was also marked by his respect for his fellow statisticians.

The breadth of understanding across statistics that featured in Professor Efron’s plenary was also in his acceptance remarks, which greatly helped to reinforce frequent comments by myself and others both at the ISI WSC and other forums, that deep learning and data science and their ilk are opportunities for statistics. They concern ‘the algorithmic side of statistical thinking, and its computational execution’. Professor Efron added:



All of this is to the good of our profession. I tell my fretful friends that we have a strong positive regression coefficient with data science, as long as we remember not to let the inferential side of statistical thinking get lost in the excitement over new technology.

The statistical community needs to increase referencing to speeches and presentations like the above. An unfortunate side-effect of the correct emphasis on research protocols and scientific evidence appears to be preoccupation with referencing journals at the expense of conference proceedings, presentations, speeches and discussion forums—and many of these are difficult to find. For example, my reference in MacGillivray (2017) to a paper at the first United Nations World Data Forums (UNWDF) no longer exists because program details are no longer on the website. To view the sources of my second UNWDF references in MacGillivray (2019) now requires working through the program to find the session and viewing a video, and it is highly likely these will disappear after the third UNWDF.

There are certainly good discussion and review papers, and excellent papers like Donoho (2017) are invaluable for statistics. It is notable that Donoho (2017) does indeed include many references to comments, blogs, presentations and speeches. As the editor of *Teaching Statistics*, a journal whose whole *raison d'être* is promotion and dissemination of best practice in teaching statistical thinking, I am constantly surprised by reference choice limitations. The emphasis on *publishing* in peer-reviewed journals should not inhibit the statistical community from therein *referencing* diverse forums encompassing the best references for furthering visibility and understanding of statistics and its impact on all dimensions of human endeavour.

### ***Far- and Deep-Sighted Statistical Leadership***

All statistical leadership, no matter how diverse the context, is characterised by a deep understanding of statistics and its global and societal roles, far-sightedness and reach across statistics. Two of many possible examples are given here, with a few references to others and papers of interest.

The history of ISI up to World War II is a fascinating story of development and collaboration. A series of congresses was initiated by Adolphe Quetelet, starting in 1853 in Brussels. From 1853 to 1885, there was emphasis on centralisation and uniformity of official statistics, that every state should have a Central Statistical Commission, and that the International Statistical Congress have a Permanent Commission. ISI was officially founded in 1885 at the London Statistical Society's 50th celebration, with 81 members from across diverse areas of application, government and academia, and 80 associates across different countries. Biennial sessions (congresses) were a core activity. In 1913, a separate Permanent Office, with separate finances to ISI, was set up to produce statistical yearbooks and maintain archives, with its treasurer an RSS officer.

One of the first League of Nations tasks was to convene a conference in London on International Cooperation in Statistics, and the International Statistical Commis-

sion was set up. ISI was a major player and collaborated with organisations such as the International Labour Office and Economic Committee. During World War II, to try to maintain some continuity, ISI members of four American countries set up the Inter American Statistical Institute. In 1948, ISI, under President Stuart Rice, and the United Nations (UN) agreed on responsibilities, with the new UN Statistical Commission (UNSC) taking over the collection and publishing of international statistical data (Rice, 1947) and ‘the exertion of influence of governmental statistical practices’ (Berze, 2002). The mission of ISI was modified in 1947, recognising that ISI

...must become more comprehensive in its scope . . . affiliations with...national, regional and specialised international statistical organisations...to the benefit of statistical science as a whole . . .

Thus ISI adapted itself to become a truly professional society relevant for the global and whole statistical community, with new aims which were visionary, far-reaching and a foundation for today’s ISI’s mission and objectives. It was both global and the original ‘big tent’, bringing together and reaching out across official and government statistics, research and development across disciplines, business and industry, computing, methodologies, mathematical statistics and education. One example of deep understanding of the nature of statistics and of foresight quite extraordinary for as early as 1948, was establishing the framework for Associations, initially called ‘sections’, having their own organisational structure, but with objectives, statutes and by-laws approved by ISI, and in harmony with those of the ISI. Associations therefore have the capacity and ability to reach out to those in the wider statistical community who might not identify themselves as ‘statisticians’ but who do identify with the Association. Some complain of the practicalities associated with this structure, but it is invaluable, indeed necessary, for a professional society, which must connect across all countries and all of statistics.

Stuart Rice was an official statistician with outstanding leadership across the diversity of statistics then and into the future, and the commitment and courage to make far-reaching innovations, bring people with him and organise. The ISI Education Committee was set up in 1948, as part of a series of constitutional changes aimed, among other things, at increasing the ISI’s mandate to undertake educational activities in statistics and to collaborate for this purpose with UNESCO and other UN agencies. Vere-Jones (1995) comments:

He persuaded the UN Statistical Commission to advance proposals to UNESCO for a shared responsibility for the development of statistical education. At the same time the statutes of ISI were revised to incorporate, among other things, an explicit responsibility for the promotion of statistical education.

The creation of the ISI Education Committee marked the beginning of a systematic education programme. Under Mahalanobis’ chairmanship (1954–1960), the ISI Dictionary of Statistical Terms, several bibliographies and Statistical Theory and Methods Abstracts were established and short courses and seminars initiated. The first international roundtable on statistics education was held in 1968.

In the 1970s, the ISI began to pay more attention to promoting statistics education in schools and universities, reflecting changes in ISI membership and increasing importance of statistics in university and school programmes. The Education Committee took new directions with the establishment of a number of task forces. Two of the most important of these were the Task Force on Teaching Statistics at School Level (TOTSAS), led initially by Vic (Victor) Barnett, and the Task Force on International Conferences in Statistical Education (ICOTS). This introduces my second example of far- and deep-sighted leadership across the diversity of statistics. The TOTSAS group established a regular newsletter (International Statistical Education newsletter) for ISI members and which was circulated to interested school and university teachers. This led to Vic and Professor Joe Gani setting up the Teaching Statistics Trust to establish the journal *Teaching Statistics*, first issued in 1979, aimed at the practice of teaching statistics to students aged 9–19 years. With Warren Gilchrist, Vic established the first (UK) Centre for Statistical Education at Sheffield and Sheffield Hallam universities in 1982 with Peter Holmes as its first Director.

One needs to read at least two different obituaries of Vic to get some idea of his leadership reach. He led developments in environmental statistics, which are honoured by the RSS Barnett award. His professional service to statistics was sustained and outstanding, and honoured by the RS Chambers medal. And he continued his leadership in statistical education, chairing the first International Conference on Teaching Statistics, and as a long-term force in support of the RSS Centre for Statistical Education. In Davies and MacGillivray (2014), Neville Davies comments:

However you look at Vic, he was remarkable; an ideas man with exceptional ability in statistics practice, theory, research, teaching, education, writing and thinking . . . His ability to explain statistical matters was extraordinary—he was equally at home in communicating statistics to school teachers and their students as he was with discussing mathematical statistics and associated research at the highest level—the mark of a great teacher.

During a secondment to the RSS, I witnessed firsthand Vic's seemingly effortless balance of approbation and constructive criticism in sessions with postgraduate students. But for me, his succinct but telling comment below (Barnett, 1986) captured his deep understanding in his leadership work across the diversity of statistics.

we see, tied up together, the role of the statistician as consultant, consultancy as the stimulus for research in statistics, and consultancy as the basis for teaching statistics

The ISI Education Committee, under the leadership of its last chair, David Vere-Jones, became the International Association for Statistical Education in 1991. Vere-Jones is another statistical leader whose abilities and insights reached across theory, challenging applications (forecasting earthquakes) and education. His plenary at ICOTS5 (Vere-Jones, 1998) linking statistics education and countries' social history, was inspirational in its insight, thought and knowledge.

## *Connecting Locally and Personally*

The value of statistical history and feeling personally connected with leaders can be seen above, but remoteness can dilute the value. How can we connect undergraduate and school students with the leaders and heroes across statistics in ways that contribute to foundations for their future work and leadership? The answer, as in so many components of learning and development, lies in student ownership—creating ways to identify with the leadership and historical elements. This essentially means that effectiveness is a product of proximity and prominence. I give here examples from my experience of three types of local and personal connections for students, all of which were more powerful than I had expected. All of these types are available to us within teaching and mentoring contexts.

The first type is students' discovering that a person they know in everyday contexts has a past involvement with, or connection to, statistical heroes, leaders, or innovators. The earliest example of this I witnessed was the reaction when undergraduate statistics majors discovered that one of my colleagues who they knew only as a friendly and mild-mannered lecturer, had done her PhD with Fisher in 1934–1936 in the Galton laboratory and Rothamsted, publishing papers on varied topics under her maiden name, in discriminant analysis (Barnard, 1935), factorial experiments (Barnard, 1936) and environmental statistics. Mildred returned to Australia to a biometrician position, which she would have normally lost on marrying in 1939, but World War II delayed her resignation until her first child was born in 1941. Mildred was studying in the London statistical community at the same time as F.N. David. This enabled me to open discussions on a range of topics which brought statistical leadership and innovations to life for the students, including:

- The pathways of female statisticians such as F. N. David (whom I had met myself at the 150th RSS Anniversary celebrations), Gertrude Cox and Elizabeth Scott;
- The many and varied paths into statistics; and
- The effects of social and world environments, especially in the first half of the twentieth century and the effects of World War II.

For example, statistics gained both David and Scott because their first discipline choices (actuarial and astronomical sciences, respectively) did not offer opportunities for women. Many scientists, statisticians, mathematicians and engineers worked on practical but far-reaching problems and projects during WWII, of which some famous ones are well known, but all of which shaped theirs and others' subsequent work. As the first vacation scholar in statistics at ANU (Australian National University), I loved hearing how Pat Moran and Ted Hannan got into statistics. The vacation scholarships at ANU were first set up for astrophysics and then extended to other STEM areas. I remember asking Pat what was I supposed to do as a vacation scholar—his reply was for an era before summer/vacation scholarships became more widespread and the business of internships and work integrated learning became more serious: 'Have a good time—and come back after honours to do a PhD'.

The second type of effective connection with leadership is tied to student ownership through student-driven discovery. In teaching topics such as stochastic processes, multivariate analysis and actuarial statistics, I included exercises or small projects in which students discovered how and/or why various theoretical or methodological results or developments came about. This also had the advantage of helping students see the combination of struggle, thinking and ability to bring ideas and concepts together and into fruition, which marks leadership in statistical development. One of the most effective of this type was an assessment project in second-year stochastic processes in which student groups chose one of the results in the course to investigate its history and to present their (group) work orally accompanied by a poster. Results in branching processes, random walks, queues and epidemics were always popular, but a memorable one was a group's determination to understand what almost certain convergence really meant and why it was of practical importance in a particular epidemic result; the theory inspired rather than deterred them because they owned their discovery journey.

The third type is connection with those closest in time or progression—those who are 'just in front' of them. Diversity here is both powerful and of core importance. From 1995 to 2004, I developed and ran, with some collegial help, an extension and enrichment program for students in their second last year of high school, in which thousands of students from hundreds of schools participated. It was called MathX, and years later I would run into past participants who said they were a 'MathX-er'. Topics in randomness vs. chaos, queues, risk and the prosecutor's fallacy, codes and cryptography, modelling and biology, were all hands-on with the emphasis on fun. The undergraduate students I chose as 'helpers' were also of great interest to the school students. This led me to develop another program for senior school students and teachers in which a diversity of past students in the workforce spoke briefly on their journey and what they were doing in their current job. The program was for a single morning (final-year students and their teachers are very busy people) with approximately 12 speakers who therefore had to request leave from their workplaces for only a short time. As in teaching, no matter how innovative or inspiring, programs for students must be practical and well organised to have any chance of success. Diversity was significant in the success of this program: diversity of workplaces, types of work, presentations and early-career speakers. Most of the speakers had majored in statistics, either as honours' graduates or within double degrees with IT, business or engineering, or were significant users of statistics in their work. One year, some school students complained that there was too much about statistics, so I henceforth took the opportunity to say that I chose the speakers because of the diversity, interest and potential of their jobs and this was why so many would refer to statistics.

Many speakers were already clearly on pathways to leadership roles and rewarding careers, both financially and with job satisfaction. By all measures, the program was an outstanding success with students, teachers and speakers, who loved doing it because of the bonding and brevity of their presentations, and ran 1998–2007, 2010. I was unable to run it in 2008, 2009 because of being on national fellowship and leadership programs, and unfortunately the era of encouraging

university community outreach was also giving way to the renewed emphasis on research above all, national research evaluation frameworks in many countries, and consequent imbalances, which have exceeded those of past eras. The Science Faculty did try to take up the program, but the essential concepts of: diversity of workplaces and speakers; many early-career past students speaking briefly of their personal journeys; and focus on workplaces rather than research; were lost.

## **Some Examples of Teaching Leadership in the Practice of Statistics and How to Develop It**

Much could be, and already has, been written on this topic. The statistical leadership model of Gibson (2019) and the associated extensive advocacy from many statistical leaders on good practice in statistics are also the characteristics of statistical leadership in teaching, and how to build the foundations for leadership in developing future statisticians, and in their future team members in other disciplines. The key competencies of Gibson (2019), namely, active listening, asking questions, networking and communication, along with authentic understanding of statistics, and I add respect for others, are the key competencies for statistical leadership in teaching, as well as those to be developed in students.

### ***Statistical Leadership in Multidisciplinary Teams in Teaching***

This refers to what is usually called ‘service teaching’ in which statisticians teach statistics to students in courses or programs in other disciplines, but extends beyond this to working on: joint curricula; school curricula; research methods for advanced or postgraduate students; workplace professional development; providing advice to colleagues; and to conducting reviews of statistics in a variety of university scenarios. Such teaching is of the utmost importance to statistics, because it is educating future statisticians (apart from school preparation, many statisticians started in other disciplines); future statistical collaborators; and all future users and supporters of statistics.

In all such contexts, the key competencies of good practice in statistics, and leadership therein, are critical for success. These contexts may involve interaction with a small number of people from a discipline other than statistics, or with many from a number of disciplines, but they will always involve people with different reference frameworks, and, in addition, there is almost always another level also to deal with, be it school educational authorities, faculty and university authorities, or workplace requirements. Reference frameworks include statistical and teaching backgrounds and current contexts, pedagogical allegiances and beliefs, and, as always, practical and financial constraints and ambitions.

For 40 years, I was involved in designing, implementing and teaching statistics curricula for other university disciplines—engineering, science, health, business, education, built environment—and always ‘gained’ rather than ‘lost’ ‘service’ teaching. It was in working with past students who became statistical consultants, as mentioned in section “[Leadership in Development of Future Statisticians and Their Collaborators and Clients](#)”, and with statistical leaders in industry and business, that I started to emphasise the commonalities and parallels in statistical leadership in teaching and in the practice of statistics. As well as the active listening, asking questions, networking and communication emphasised in Gibson (2019), I add some other advice from leading statistical consultants—about being good consultants—but my assertion is that the same applies to statistical leadership in teaching. This advice includes:

- Distinguish between ‘meeting client expectations and addressing client needs’ McLachlin (2000);
- Understand ‘the need to solve the right problem’ (Zahn & Boroto, 1989)
- ‘Be willing to meet clients regularly on their home ground’ (Joiner, 2005)
- ‘Be a good teacher—much success in consulting depends on being able to help others understand statistical tools, and their strengths and weaknesses’. (Joiner, 2005)
- ‘To be able to respond properly to the needs of the client, it is important to take part in the collection of data, or at least have the opportunity to watch data being collected or generated’ (Kenett & Thyregod, 2006)

Some of the above points need translation and/or transference to teaching, and some need considerable thought. The client(s) are at least threefold in teaching, consisting of the staff in the other discipline(s), the students, and the discipline(s) itself. The ‘home ground’ is the context of the other discipline(s) and the opportunities and constraints of the degree program, including the financial inter-faculties competitions that unfortunately so often distract genuine collaboration away from the interests of the students. The ‘data’ are extensive, complex and ongoing. Here I use the term ‘course’ for the unit, subject or paper—the named entity for which students receive a grade within their program of study. The data include what the other discipline wants and what they need, their statistical framework and beliefs, the logistics of the course, what the students bring into the course, the discipline norms and future courses for which the students need to be prepared, and how the students react to the overall curriculum of the course—content, learning experiences, development of skills and assessment. The last data—how students react—are constantly being collected, and require ‘frontline’ as well as ‘remote’ collection. ‘Frontline’ means listening and participating in students’ learning experiences, and observing what they do and write in open-ended assessment, both formative and summative. Frankness with students about discipline norms is part of explaining the challenges of uncertainty, variation and data in their discipline and its workplaces, and the potential for improvements through statistical thinking.

I listen carefully to other disciplines’ desires and frameworks, find out as much as I can, and transmute this into a realistic model that meets their students’ needs

both immediate and long term. This should be explained, justified, evidenced and inspiring to the other discipline(s). The benefits of the statistical leader continuing with collaboration with the other discipline(s) are immeasurable, keeping them up to date with personal input and feedback, as well as the more usual qualitative (survey) and quantitative (assessment) data. 'Service' teaching often involves large classes, with associated feelings for staff of being overwhelmed, but my observation and advice are that the best ways to achieve balance are always through analysis, planning and organisation, and that attempts to save time through avoidance of issues, often backfire. It is possible to participate in students hands-on learning experiences across the whole cohort provided one plans and uses sampling of workshops and computing labs. It is possible to include open-ended learning experiences and assessment, because these can be balanced by cleverly designed preparation and other quiz-type assessment.

Perfect curricula and programs do not exist, and inevitably disciplines make changes, including reverting to previous arrangements. In 30 years of teaching into engineering, I taught different areas of engineering all together, in various combinations, in various year levels and with various arrangements of lectures, workshops, tutorials and computer labs. Such changes are part of the constant seeking for improvement, but the given principles always hold, and our job as statistical leaders within the teams is to genuinely collaborate but always with focus on student learning.

There is no fixed introductory course in statistics and no fixed content order. Being beholden to such beliefs has held back statistical reform. Time, logistics, student background, level and outcomes all help in statistical leadership in curriculum development. Time should always be used efficiently and productively for the particular student cohort no matter what their diversity of backgrounds. For example, called in to help with significant student discontent in a 6-week MBA course, I discovered they were being given the first half of a first year Business statistics course. The quantitative background of working graduates in the MBA course was certainly diverse, but they needed to see what statistics could do for them, from data exploration and presentation through to multiple regression and time series in 6 weeks. In contrast, postgraduate research students in other disciplines needed to see the fundamental roles of statistics and statistical thinking in research, and how their discipline research norms fitted on top of those. Electrical and computer engineering students needed to see queueing and risk in ways to prepare for how their industry lecturers would present these. In another example, I was asked by an overseas colleague what to do in just the 4 weeks allocated to statistics by the Chemical Engineering Department. When the answer to my question of what was most important for them to see, was industrial experimental design, we moved directly to that.

For content and its development, think always of coherence and the statistical story that will maintain engagement and learning by the student cohort for the whole course, and not just at the beginning which is easy to do. General principles include moving quickly and purposefully to the capacity and power of statistics for them, and designing hands-on learning experiences which they authentically



own. One of the biggest challenges has always been obtaining real contexts and data in which students can genuinely explore and learn statistical thinking, without the context domination or top-down instruction that can bedevil case studies. In 15 years of successful student discovery projects in data analysis and stochastic processes in large introductory classes across disciplines (for overviews, see Forster & MacGillivray, 2010, and Gibbons & MacGillivray, 2014), my statement to curricula reviewers was always that students learn statistics best in what they want to investigate.

Reviews of curricula in universities, working on school curricula with teachers and educational authorities, and working with business and industry on workplace professional development, all need the full statistical leadership and investigation processes of active listening and observation, identification of issues, sourcing and discovering information (data), analysis, synthesis and modelling, communication of findings or product, and evaluation and reflection. There should be more outlets to showcase the variation possible in statistical curriculum design to meet the variety of time, logistics, disciplines, students, levels and contexts—all scholarly written and embedding the full statistical consultancy process from first thoughts to evaluations, analysis and further work.

### ***Leadership in Development of Future Statisticians and their Collaborators and Clients***

As mentioned in section “[Leadership in the Practice of Statistics and How to Develop It](#)”, there is rapidly increasing recent commentary on the need for developing the so-called soft skills in statistics of listening, networking and communication, especially in developing future statistical leaders. Gibson (2019) comments on the increasing work-integrated learning and hands-on learning of statistical consulting skills in postgraduate courses in the US. However, such advocacy has been heard from statisticians and statistical educators for many years. Donoho (2017) includes advocacy from past years on statistical directions and associated education of future statisticians. Kenett and Thyregod (2006) identify five steps of statistical consulting:

- Problem elicitation
- Data collection and/or aggregation
- Data analysis using statistical methods
- Formulation of findings, their consequences and derived conclusions
- Presentation of findings and conclusions/recommendations

They strongly advocate that university education of statistics majors must strongly emphasise the first two steps and the last step, also saying that not being involved in collecting data has led some graduates to be of the opinion that taking part in the collection of data is a waste of the statistician’s precious time, and it even implies the risk of getting dirt on your hands.

All those involved in statistics education over the past decades—and back to the 1970s for some—will recognise the above as another description of the

statistics data investigation process, also known as the data investigative cycle, the statistical problem-solving cycle and the data-handling cycle introduced in UK school curricula in the 1970s (Holmes, 1997). Statistics educators are familiar with it expressed as the Plan, Collect, Process, Discuss (PCPD) and the Problem, Plan, Data, Analysis, Conclusion (PPDAC). Cameron (2009) also provides a five-point expression of this process, based on the writings of Box (1976) and Chambers (1993). In considering the desirable key components of university-based training of a statistician to prepare for a research consulting career in an organisation involving multiple disciplines and with objectives to create economic, environmental, or community value, Cameron (2009) also comments that thorough grounding in this full process is an appropriate foundation for most statisticians wherever they may be employed. Add to this, other advocacy from statistics educators and statisticians such as:

Students will understand material only after they have constructed their own meaning for what they are learning (Garfield, 1995)

Student-centred and active problem-tackling in a problem-solving environment is described by Gal, Ginsberg, and Schau (1997) as

an emotionally and cognitively supportive atmosphere where students feel safe to explore, comfortable with temporary confusion, belief in their ability and motivation to navigate stages.

Taplin (2003) commented

If students learn best from making their own mistakes, then a dominant role of educators is to place students in positions where they make these mistakes safely.

As mentioned in section “[Leadership and People](#)”, Taplin (2003) was one of the statistical leaders who developed successful experiential learning of statistical consulting at undergraduate level. Do the courses mentioned there still exist? No. Why such initiatives and emphasis have had so little penetration or leverage is a matter deserving very serious consideration and action by statistical leaders worldwide. There are many reasons for this lack of penetration, and understanding these rather than finding blame is essential. For example, much of the problem is associated with the research pressures in universities, including publishing in high-impact journals, acquiring HDR students, obtaining research funds, and placing teaching, consulting, collaboration with other disciplines and professional service well behind research. Balance in universities has always been, and will always be, of both critical value and a challenge, but the challenge for statistics is far greater than for other disciplines, and the situation in many countries is worse now than 40 years ago because of mixed and hypocritical messages to early-career staff.

For the development of future statisticians and statistical leaders, the above do not just apply to data analysis but to all of their education. No matter what the topics or methodological content, the messages are clear. Our future statisticians need embedded in all their courses:

- Experiential and constructivist learning
- Environments facilitating exploring and learning problem-solving
- Statistical thinking in all its manifestations
- Communicating, collaborating, constructing meaning.

In analysing how to develop the essential skills for statistical consulting and the statistical leadership of Gibson (2019), Gibbons and MacGillivray (2014) include not only description of the types of courses, which meet the above advocacies, but also how to build on these to develop the key skills of communication of statistics to others—that is, how to teach statistical understanding. These were developed through a developmental and mentored program involving:

- 1–2 h a week voluntary service in a learning support centre, providing one-to-one assistance in an informal friendly environment with no time pressures or formal obligations, and with any concerns or difficulties referred to centre director;
- Followed by training in tutoring;
- Followed by mentored sessional teaching.

Many continued with some voluntary service, and typical comments from all participants were:

Fantastic! Love it  
 Brilliant for learning  
 One-to-one conversations to learn ways of explaining  
 Love being able to help with no pressure

Extensions of these principles to mentoring and supporting early career staff include swapping roles; sharing resources; team reflections and analysis; adapting resources to other teaching contexts; articulating criteria and standards; designing integrated authentic, effective but efficient assessment; identifying strengths of individuals and strategies; and a range of interactive collaborations designed to assist early-career staff to develop teaching strengths as well as balance their workloads and further their careers and career satisfaction. These are all part of active and inclusive mentoring that is predicated on authentic collaborative and sharing partnerships between mentor and mentees. More formal mentoring programs in workplaces can involve performance evaluation of some type, which can be important for formal career progression, but for authentic learning ‘on the job’, the type of mentoring described here is invaluable.

Graduates who went on to a range of statistical workplaces have attested to the value of learning to communicate and work collaboratively with other disciplines on often complex applied problems. The analogies to learning to be an effective statistical consultant are numerous and obvious. However, it must be emphasised that the value in the tutoring experience was because of the nature of the tutorials, the pedagogies of the courses, and the collaborative mentoring of the lecturer/course coordinator. The focus of the tutorials was on working with the students, facilitating their learning, and not on merely standing in front of a class providing instruction. The pedagogical approaches of the courses were similar, providing experiential

learning of the full data investigation cycle and problem-solving in probability and distributional modelling, in an environment of collaborative and supportive learning.

## **Statistical Leadership in Professional Societies**

### *Diverse Roles for a Diverse Discipline*

Professional societies are their people. Their essence is to build community, to help the community service itself and to help in representing the community. They do not exist independently of, or externally, to their community. Humanistic and inclusive leadership is therefore essential for their health and mission. The characteristics of humanistic leadership (Nathanson, 2017) are highly relevant:

participating as a collective whole . . . . There should be a transparent communication and collaboration . . . . The key tenants of humanistic leadership are placing the needs of people over profit, to have empathy and respect for others.

The strength of a professional society comes from its membership. Simply being a member contributes to this strength and enables the society to service itself, represent the profession and have impact and influence externally. Because of the inherent diversity and intertwining of statistics across disciplines and society, and because statistics services humanity, there needs to be more emphasis that strength of statistical societies comes from diversity of their membership.

Leadership of statistical societies must therefore be always conscious and inclusive of this inherent diversity. Much of the characteristics of good statistical leadership in multidisciplinary teams discussed above also applies to leadership of statistical societies: active listening, asking questions, networking and communication. Added to these are the humanistic characteristics of transparency and respect. In all statistical societies, these involve awareness of, and respect for, diversity of workplaces, people and cultures. All these leadership characteristics need effort, but are particularly in the diversity and dispersion of international statistical societies in which inclusive and humanistic leadership are even more challenging but vital. An additional aspect very important for the statistical profession is mentoring of the type discussed in section “[Leadership in Development of Future Statisticians and Their Collaborators and Clients](#)”. This is the mentoring inherent in bringing people into active roles in the society and developing leadership potential. It is a natural human tendency to think of and/or suggest people one knows and/or from one’s own country or area of statistics for active roles, but leadership includes responsibility to use all possible means to reach out to the whole membership and help the membership connect with each other. Surveys, news about members, electronic and face-to-face informality and friendly discovery, and constantly aiming to widen and broaden participation in roles, all contribute to productive leadership.

Servicing the community and representing the community are closely interwoven. Journals, conferences, awards, sponsorship, workshops, symposia, websites,

other publications, commentary and presentations are all service to members and the public face of statistics. In surveys of ISI members, conferences and statistical events, global span and statistical coverage and information, professional community, networking and members' news, were all much valued, but there was also clearly desire for more to increase the visibility, communication and impact of statistics, especially in the environment of big data, data analytics and data science. Much has been done in recent times on communication of statistics and public voice, but as discussed here, particularly in Sections "[Leadership in the Practice of Statistics and How to Develop It](#)", "[Connecting with Giants](#)" and "[Some Examples of Teaching Leadership in the Practice of Statistics and How to Develop It](#)", more is needed on 'greater statistics' and its practice, the diversity of statistics and its contributions, the understanding and use of statistics, statistical thinking and the whole process of statistical investigations and problem-solving, all forms of communication of statistics and its teaching, and authentic statistical leadership. Journals and all publications, conferences and all forms of public voice, and the whole statistical community need broader vision, outreach and collaboration. I discuss below the current example of data science.

### ***Briefly on Data Science***

As mentioned in section "[Connecting with Giants](#)", Donoho (2017) demonstrates outstanding statistical leadership, not only in his excellent exposition and arguments, but also in bringing together pertinent references from a wide range of forums, both written and spoken, over many years. I have referred to Chamber's (1993) 'greater statistics', as well as many other leading statisticians, in many forums over the years in writing or speaking about teaching statistics to reflect the practice of statistics, and Donoho (2017) extends this to 'greater data science'. Donoho comments that exhortations from statisticians to change paths, particularly in academic and research statistics, towards a much broader definition of their field, had relatively little apparent effect before 2000. This parallels the advocacy over decades from statisticians and statistics educators that teaching statistics should reflect the practice of statistics as in 'greater statistics'. In order for the 'big tent' statistical community to pull together on all fronts, it is necessary to understand why such advocacy did not have the needed penetration. It is not that such advocacy was unacceptable. The nature of statistical thinking itself, the extraordinary diversity, enormity and intertwining of statistics across disciplines, workplaces and society, and Rodriguez's (2013) 'unselfishness' of statistics, all contribute to the challenges of authentic and deep implementation of such advocacy, and not just lip service or shallow change. What is encouraged, supported and rewarded in the great diversity of workplaces in which those with statistical training and capabilities find themselves, is also a key factor.

The boundaries between statistics and other disciplines are often blurred, but data science is different. Statistics has also been both a user and driver of computing

technology since the first computer occupied a whole basement. Statistics is the science of uncertainty, variation and data; data science is the science of data. Big data, data availability and massive computer power have brought data science ‘out from the back room’ and have both driven, and been driven by, statistics and data science. However one describes statistics and data science, they are clearly inextricably together as a broad discipline. This is the business of us all; we must bring to attention both within and outside the whole statistical community, everything that helps in understanding and preventing misunderstandings, in order for statistics and data science, not; however they are described, to advance their common mission and identity as the sciences of uncertainty, variation and data.

For example, recent descriptions of data literacy are identical with long-established descriptions of statistical literacy, and a description of ‘opportunities for engagement’ in data literacy (reported in MacGillivray, 2017) at the first UN WDF was nothing more than a description of the statistical data investigation process, expressed as PCPD or PPDAC as discussed above in section “[Leadership in Development of Future Statisticians and Their Collaborators and Clients](#)”. Because a great cross-section of government and social organisations are focussed on the UN Sustainable Development Goals (SDG’s), for which much is concerned with official statistics and data for development and citizen benefit, the emphasis of statistical/data literacy in these contexts is on citizen empowerment, but it is imperative that we speak up and out when we see denials of statistics whether deliberate or unintentional. It is most unfortunate that in the International Data Science for Schools Project (<http://www.idssp.org/>), there is insufficient linking with decades of advocacy and work in statistics education, with even the well-known PPDAC renamed the Data Science Learning Cycle without reference to all the work on PCPD, PPCAD and other descriptions of the statistical data investigation cycle. As a US professor of statistics privately commented in 2019, there are many

people who all have their fingers in the “data science” pie; and most of them know nothing of statistics nor of the long history of statistics education to develop exactly the ideas they wish to see implemented.

At the second UN WDF, a session called ‘Data Scientists: What are they?’ (<https://undataforum.org/WorldDataForum/sessions/ta6-08-data-scientist-what-are-they/>) had speakers leading data science teams in large organisations across industry, business and government, including communications, securities, information technologies and official statistics. Their comments centred on three key points, namely:

- Data science is everywhere and not new;
- Data science is not a person effort—it’s a team “sport”, and diversity in the team is essential;
- However statistics and data science are described, statistics is fundamental to data science.

Such comments from data science leaders echo commentary from statistical leaders like Donoho (2017) and Efron (2019). Statistical societies and leaders must

take every opportunity to ensure ‘greater statistics’ is front and centre in awareness across disciplines and the public, including in ‘greater data science’.

## Brief Concluding Remarks on Inclusive Leadership Across the Diversity of Statistics

In section “[Leadership and People](#)”, I included the ‘six signature traits’ of inclusive leadership (Bourke and Dillon (2016) in a general business setting. These have been implicit in the context of this chapter, so I conclude with some explicit comments under their headings applied to the statistical and data sciences. These are also advice for leadership across the diversity of statistics.

- ‘Commitment’ is to the broad tent of the statistical sciences, to its community, integrity and diverse roles in its contributions to all fields and to human welfare.
- ‘Courage’ is in speaking out, representation and advocacy of the practice and teaching of ‘greater statistics’, and support of other statistical leaders.
- ‘Curiosity’ is active listening, asking questions, and thinking outside the box.
- ‘Cognisance’ is reflecting, analysing, seeing and synthesising the big picture in statistics and articulating its meaning.
- ‘Cultural intelligence’ is respect, discovery of others’ frameworks and adapting in building authentic, productive and progressive community.
- ‘Collaboration’ is at the heart of all the above and the whole statistical community.

We need to add another, also starting with C:

- ‘Communication’ within and across the whole statistical community, with collaborators, with students and with the global community of statistical users and all citizens.

## References

- Barnard, M. M. (1935). The secular variations in skull characters in four series of Egyptian skulls. *Annals of Eugenics*, 6(4), 352–371.
- Barnard, M. M. (1936). An enumeration of the confounded arrangements in the  $2 \times 2 \times 2 \dots$  factorial designs. *Supplement to JRSS*, 3(2), 195–202. <https://doi.org/10.2307/2983671>
- Barnett, V. (1976). The Statistician; jack of all trades, master of one. *The Statistician*, 25(4), 261–279.
- Barnett, V. (1986). Statistical consultancy - a basis for teaching and research. In R. Davidson (Ed.), *The Proceedings IASE/ISI 2nd International Conference on Teaching Statistics, Vancouver*. Voorburg, The Netherlands: ISI. Retrieved from <http://iase-web.org/documents/papers/icots2/Barnett.pdf>
- Berze, D. (2002) ISI in the Postwar period: Planting the seeds of statistical education. In: *International Conference on Teaching Statistics (ICOTS)*, Vol. 6. Retrieved from [http://iase-web.org/documents/papers/icots6/5b2\\_berz.pdf?1402524962](http://iase-web.org/documents/papers/icots6/5b2_berz.pdf?1402524962).

- Boen, J. R., & Zahn, D. A. (1982). *The human side of statistical consulting*. Belmont, CA: Lifetime Learning.
- Bourke, J. & Dillon, B. (2016). *The six signature traits of inclusive leadership: thriving in a diverse new world*. Retrieved from <https://www2.deloitte.com/us/en/insights/topics/talent/six-signature-traits-of-inclusive-leadership.html>.
- Box, G. E. P. (1976). Science and statistics. *Journal of American Statistical Association*, 71, 791–799.
- Cabrera, J., & McDougall, A. (2002). *Statistical consulting*. New York: Springer.
- Cameron, M. (2009). Training statisticians for a research organisation. In *Proceedings of the international statistical institute 57th session*. Durban, South Africa: ISI.
- Chambers, J. M. (1993). Greater or lesser statistics: A choice for future research. *Statistics and Computing*, 3, 182–184.
- Davies, N., & MacGillivray, H. L. (2014). Obituary. *Teaching Statistics*, 36(3), 97–98.
- Derr, J. (2000). *Statistical consulting: A guide to effective communication*. Pacific Grove, CA: Brooks/Cole.
- Donoho, D. (2017). 50 years of data science. *Journal of Computational and Graphical Statistics*, 26(4), 745–766.
- Efron, B. (2019). *Acceptance speech*. Retrieved from <https://statprize.org/pdfs/2019-Efront-AcceptanceSpeech.pdf>.
- Forster, M., & MacGillivray, H. L. (2010). Student discovery projects in data analysis. In C. Reading (Ed.), *The Proceedings IASE/ISI 8th International Conference on Teaching Statistics, Ljubljana*. Voorburg, The Netherlands: ISI. Retrieved from [http://icots.net/8/cd/pdfs/invited/ICOTS8\\_4G2\\_FORSTER.pdf](http://icots.net/8/cd/pdfs/invited/ICOTS8_4G2_FORSTER.pdf).
- Gal, I., Ginsberg, L., & Schau, C. (1997). Monitoring attitudes and beliefs in statistics education. In I. Gal & J. Garfield (Eds.), *The assessment challenge in statistics education* (pp. 37–54). Amsterdam, Netherlands: IOS Press.
- Garfield, J. (1995). How students learn statistics. *International Statistical Review*, 63, 25–34.
- Geller, N. L. (2011). Statistics: An all-encompassing discipline. *Journal of American Statistical Association*, 106, 1225–1229.
- Gibbons, K., & MacGillivray, H. L. (2014). *Education for a workplace statistician*. In H. L. MacGillivray, M. Martin, & B. Phillips (Eds.), *Topics from Australian Conferences on Teaching Statistics: OZCOTS 2008-2012* (pp. 267–294). New York: Springer.
- Gibson, E. W. (2019). Leadership in statistics: Increasing our value and visibility. *The American Statistician*, 73(2), 109–116. <https://doi.org/10.1080/00031305.2017.1336484>
- Holmes, P. (1997). Assessing project work by external examiners. In I. Gal & J. Garfield (Eds.), *The assessment challenge in statistics education* (pp. 153–164). Amsterdam, Netherlands: IOS Press.
- Jersky, B. (2002). Statistical consulting with undergraduates—A community outreach approach. In *The Proceedings IASE/ISI 6th International Conference on Teaching Statistics, Capetown*. Voorburg, The Netherlands: ISI. Retrieved from [http://iase-web.org/documents/papers/icots6/3a1\\_jers.pdf](http://iase-web.org/documents/papers/icots6/3a1_jers.pdf).
- Joiner, B. (2005). Statistical consulting. In S. Kotz, N. Balakrishnan, C. Read, & D. Vidakovic (Eds.), *Encyclopedia of statistical sciences* (2nd ed.). New York: Wiley.
- Kenett, R., & Thyregod, P. (2006). Aspects of statistical consulting not taught by academia. *Statistica Neerlandica*, 60(3), 396–411.
- MacGillivray, H. L. (2017). You know what I mean. *Teaching Statistics*, 39(2), 39–41.
- MacGillivray, H. L. (2019). Data science, statistical investigations, team sport, and assessment. *Teaching Statistics*, 41(1), 1–2.
- McLachlin, R. D. (2000). Service quality in consulting: What is engagement success? *Managing Service Quality*, 10, 239–247.
- Nathanson, C. (2017). *The Humanistic Leadership Model (HLM)*. Retrieved from <https://drcraignathanson.com/the-humanistic-leadership-model-hlm/>.
- Rangecroft, M., & Wallace, W. (1998). Group consultancy, as easy as falling off a bicycle? In L. Pereira-Mendoza, L. S. Kea, T. W. Kee, & W. Wong (Eds.), *The Proceedings of the*



- 5th International Conference on Teaching Statistics, Singapore* (pp. 359–364). Voorburg, The Netherlands: ISI.
- Rice, S. A. (1947). *Explanatory statement and commentary accompanying the formal proposal for revision of the statutes*. Mimeographed document, ISI Archives.
- Rodriguez, R. (2013). Building the big tent for statistics. *Journal of American Statistical Association*, 108, 1–6.
- Rodriguez, R. (2015). Who will celebrate our 200<sup>th</sup> anniversary? Growing the next generation of ASA members. *The American Statistician*, 69, 91–95.
- Russell, K. G. (2001). The teaching of statistical consulting. *Journal of Applied Probability*, 38A, 20–26.
- Smith, H., & Walker, J. (2010). Experiences with research teams comprised of graduate students, faculty researchers, and a statistical consulting team. In C. Reading (Ed.), *The Proceedings IASE/ISI 8th International Conference on Teaching Statistics, Ljubljana*. Voorburg, The Netherlands: ISI. Retrieved from [http://iase-web.org/documents/papers/icots8/ICOTS8\\_4H1\\_SMITH.pdf](http://iase-web.org/documents/papers/icots8/ICOTS8_4H1_SMITH.pdf).
- Smyth, G. K. (1990). Experiences in training students in statistical consulting and data analysis. In *The Proceedings of the 3<sup>rd</sup> International Conference on Teaching Statistics, Dunedin* (pp. 446–450). Voorburg, The Netherlands: ISI.
- Taplin, R. H. (2003). Teaching statistical consulting before statistical methodology. *Australian & New Zealand Journal of Statistics*, 45, 141–152.
- Taplin, R. H. (2007). Enhancing statistical education by using role-plays of consultations (with discussion). *Journal of Royal Statistical Society A*, 170(2), 267–300.
- Thorne, T., & Root, R. (2002). Community-based learning: Motivating encounters with real-world statistics. In *The Proceedings IASE/ISI 6<sup>th</sup> International Conference on Teaching Statistics, Capetown*. Voorburg, The Netherlands: ISI. Retrieved from [http://iase-web.org/documents/papers/icots6/3a3\\_root.pdf](http://iase-web.org/documents/papers/icots6/3a3_root.pdf).
- Vere-Jones, D. (1995). The coming of age of statistical education. *International Statistical Review*, 63(1), 3–23.
- Vere-Jones, D. (1998). Background influences on the development of statistical education. In *Plenary paper, International Conference on Teaching Statistics (ICOTS)*, (Vol. 5). Retrieved from <http://iase-web.org/documents/papers/icots5/Keynote4.pdf?1402524956>.
- Wasserstein, R. (2015). Communicating the power and impact of our profession: A heads up for the next executive directors of the ASA. *The American Statistician*, 69, 96–99.
- Zahn, D.A., & Boroto, D.R. (1989). The wanted and needed conversation: A tool to enhance consulting effectiveness. In *ASA Proceedings of the Statistical Education Section 1989* (pp. 66–67).

# Index

## A

- Ability(ies), 4, 6, 20, 24, 34, 37, 43, 51, 70, 83, 90–95, 97, 105, 107–109, 112, 113, 132, 134, 137–139, 158, 159, 163, 169, 171–173, 181, 198, 206, 215, 243, 244, 298, 305, 311, 329, 331, 337, 355, 358, 381, 392, 394, 395, 397, 402
- Acceptance, 10, 75, 95, 100, 143, 144, 147, 151, 228, 316, 336, 337, 392
- Access, 4, 9, 11, 14, 24, 34, 36, 39, 41–43, 51–55, 68, 69, 107, 114, 132, 137, 144, 222–224, 228, 241, 245, 247–249, 298, 311
- Accessible, 34, 36, 158, 206, 239, 242, 244, 246–248, 251, 252, 286, 302, 311
  - inaccessible, 247, 311, 314
  - non-, 251, 315
  - wheelchair, 252, 311
- Accommodation, 11, 224, 241, 245–247, 249, 251, 252
  - reasonable, 9, 241, 244–247
- Accountability, 47, 53, 58, 150
- Accountable, 14, 20, 22, 26, 176, 177, 313, 315
- Achievement, 11, 39, 74–76, 81, 108, 122, 177, 179, 233, 234, 312, 316, 322, 323, 330, 332, 366, 389, 392
- Acknowledgement, 332, 390
- Action, 4, 37, 57, 90, 107, 117, 132, 154, 168, 172, 188, 225, 240, 260, 279, 297, 309, 322, 377, 402
  - call to, 161, 280, 297, 309, 310, 312–314, 316, 317
  - plans, 17, 58, 100–101, 114–115, 181, 201, 218, 240, 252, 312, 313, 317
  - points, 27, 208–209, 235–236, 306–307
- Actionable, 4, 18, 43, 276, 288
- Activism, 228, 234
- Adjust, 193, 323
- Adjustable, 246
- Adjustments, 108, 246, 284
- Administrative, 25, 34, 48, 49, 55, 60, 111, 166, 192, 193, 197, 205, 281, 285, 334, 383
- Administrator, ix, 8, 189, 193, 204, 225, 279, 344, 377
- Admissibility, 262
- Admissible, 260, 270
- Advance, 17, 32, 36, 39, 50, 51, 54, 55, 59, 60, 118, 121, 135, 140, 163, 167, 171, 176, 177, 234, 236, 240, 249, 252, 258, 285, 304, 347, 371, 378, 394, 406
- Advancement, 9, 27, 49, 50, 55, 56, 133, 149, 168, 178, 215, 240, 242, 256, 280, 329, 392
- Advantage(s), 11, 20, 71, 132, 138, 148, 163, 335, 343, 397
  - competitive, 172, 173
- Adversary, 228, 303
- Adversity, 96, 99, 100
- Advice, 37, 124, 142, 193, 198, 288, 366, 371–373, 378, 387, 390, 398–400, 407
- Advocacy(ies), 10, 151, 176, 234, 314, 315, 377, 398, 401–403, 405–407
- Advocate, 21, 24, 26, 43, 53, 54, 58, 59, 82, 90, 110, 115, 118, 121, 134, 151, 156, 160, 187–201, 228, 314, 315, 322, 331, 364, 368, 377, 401
- Advocating, 21, 269, 315, 390
- Affirmative action, 4, 172, 233

- African American, 5, 9, 12, 25, 156, 189, 197, 229, 278, 280, 282, 361
- Afrocentric, 312
- Age, 9, 16, 24, 91, 132, 137, 144, 145, 151, 162, 163, 222, 224, 228, 230, 231, 244, 247, 255, 264, 265, 268, 269, 285, 294, 306, 341–343, 375
- Age bias, 143, 144
- Age Discrimination in Employment Act (ADEA), 162, 224, 225
- Aims, 12, 16, 35, 126, 176, 178, 302, 394
- Alliance for Graduate Education in the Professoriate in Mississippi, 215
- Ally(ies), 39, 59, 160, 314, 315, 345
- Almanac, 286
- Altruism, 79
- Altruistic, 23, 120
- Alumni, 216, 217
- Amendment, 222, 224, 235, 239, 241, 252
  - Eighth amendment, 227
  - Fifth amendment, 221
  - Fourteenth amendment, 221, 224
  - Nineteenth amendment, 222, 236
  - Sixth amendment, 226
- American Association for the Advancement of Science (AAAS), 240, 242
- American Association of People with Disabilities (AAPD), 243
- American Association of University Professors (AAUP), 192, 203, 207, 231, 278, 286, 377
- American Community Survey, 240, 286
- American Indian, 5, 12, 13, 194
- American Mathematical Society (AMS), 234, 275, 278, 279, 281–285, 289, 290, 376
- American, native, 134, 178, 215
- American Sign Language (ASL), 245, 250, 290
- American Society for Quality (ASQ), 325
- American Statistical Association (ASA), 3, 4, 16, 22, 112, 113, 153, 154, 159, 160, 178, 195, 196, 198–200, 240, 242, 247, 252, 275, 281, 284, 286, 290, 306, 325, 331, 350, 353, 362, 363, 365, 366, 371, 375, 379, 381, 383, 392, 394
- Americans with Disabilities Act (ADA), 162, 239, 241, 244–245, 247, 249–252, 311
  - National Network, 244, 247
  - requirements, 245, 247
- Amicus brief, 230
- Animus, 262
- Annual Biomedical Research Conference for Minority Students (ABRCMS), 215
- Annual Survey, 275–278, 280–282, 284, 289
- Annual Survey of the Mathematical and Statistical Sciences, 275, 276
- Annual Survey of the Mathematical Sciences, 275
- Annuities, 229, 231
- Antiracism, 158
- Antithesis, 297
- Anxiety, 113, 249
- Application, 5, 17, 25, 39, 50, 51, 66–69, 123, 146, 197, 215, 228, 232, 239, 242, 260, 265, 269, 306, 323, 332, 335, 344, 355, 366, 375, 381, 391, 393, 395
- Application process, 245–246
- Appointment, 11, 17, 55, 194, 205, 242, 364
- Asian, 3, 159, 179, 194, 195
- Assess, 22, 41, 42, 48, 90, 100, 108, 122, 134, 139, 142, 150, 156, 168, 170, 174–177, 180, 181, 192, 201, 256, 261, 365
- Assessing, 41, 59, 100, 113, 172, 174–176, 261–263, 268, 372
- Assessment, 15, 123, 145, 150, 173, 179, 200, 206–208, 299, 378, 397, 399, 400, 403
- Association for Women in Mathematics (AWM), 234, 235, 290
- Attitude, 34, 96, 98, 133, 175, 179, 213, 249, 301, 305, 365
- Attract, 42, 135, 174, 176, 178, 181, 209, 214, 218
- Attracting, 172–178, 214, 243
- Authentic, 14, 98, 398, 403, 405, 407
- Authentically, 400
- Authenticity, 37
- Authority, 20, 40, 51, 54, 68, 94, 97, 121, 157, 158, 257, 329, 398, 401
- Authorship, 48, 52, 56, 59
- Award, 15–18, 55, 56, 60, 110, 111, 114, 161, 167, 176, 192, 205, 208, 212–214, 218, 234, 256, 266–267, 324, 331, 332, 337, 354, 378, 392, 395, 404
- Awareness, 14, 58, 89, 91, 95, 98–100, 107–109, 133, 134, 143, 145, 177, 208, 244, 248, 249, 251, 252, 276, 280, 289, 309–314, 317, 323, 330, 337, 365, 371, 376, 404, 407
- B**
- Background, 5, 8, 13, 47–49, 68, 74, 84, 106, 107, 120, 126, 132, 135, 136, 145, 148, 149, 165–169, 203–204, 212, 213, 240–241, 270, 287, 299, 302, 306, 343, 350, 353, 354, 356, 388, 398, 400
- Balance, 36, 40, 138, 140, 141, 143, 167, 276, 280, 336, 361, 383, 395, 400, 402, 403

- Balanced, 40, 98, 107, 108, 180, 181, 400
- Barriers, 35, 38, 41, 179, 208, 242, 251, 314, 316
- Battle, 81, 222, 225, 297, 348, 373
- Behavior(s), 13, 14, 23, 37, 40, 43, 89, 91–95, 97, 120–122, 124, 133, 134, 136, 139, 142, 144, 151, 154, 156, 167, 169, 173, 174, 179, 180, 229, 249–251, 288, 313, 314, 341, 344
- modeling, 288
- Beliefs, 14, 95, 110, 159, 165, 179, 252, 280, 293, 358, 365, 398–400, 402
- Belong, 156, 189, 221
- Belonging, 98, 134–136, 154, 259, 329
- Belongingness, 329
- Benchmarking, 149
- Benefits, v, 10, 12, 13, 15, 20, 24, 25, 27, 34, 35, 38, 41, 47, 79, 95, 98, 132, 134, 136, 138, 140, 141, 145, 150, 159, 173, 180, 190, 214, 217, 218, 222, 228–230, 232, 233, 235, 239, 244–247, 258, 287, 304, 322, 330–332, 336, 384, 391, 394, 400, 406
- survivor, 222, 228
- Best practice, 135, 139, 149, 150, 155, 158, 176, 177, 393
- Bias, 9, 19, 44, 83, 133, 156, 166, 171, 200, 204, 232, 249, 264, 279, 314, 348, 380
- cognitive, 378
- conscious, 133, 137, 235
- implicit, 15, 19, 24, 151, 158, 159, 161, 166, 169, 174, 175, 200, 247, 248, 252
- literacy, 133
- maternal wall, 174
- prove it again, 174
- tightrope, 174
- unconscious, 133, 135, 137, 138, 143, 145, 149, 158, 169, 174, 175, 235
- Big data, 36, 57, 118, 375, 387, 405
- Big picture, 81, 379, 392, 407
- Big tent, 4, 159, 394, 405
- Bill of Rights, 223
- Biometric Society Eastern North American Region (ENAR), 178
- Bisexual, 188, 189, 279
- Black, 5, 32, 82, 134, 150, 160, 166, 194, 196
- Blackwell, D.H., 3, 282
- Blind, 329
- refereeing, 234
- spot, 14, 111–112, 175, 301
- Bonding, 397
- Brain, 33, 91, 92, 107, 109, 117–125, 212, 250, 276, 346
- Brain-based, 125
- Brand, 296, 380
- Brown v. Board of Education, 222
- Burden, 23, 24, 26, 35, 55, 168, 203, 208, 257, 260, 261, 265, 269, 287, 332
- Burden of proof, 257, 260
- Burden shifting, 256, 260, 270
- Bureau of Labor Statistics (BLS), 154, 286
- C**
- Capability(ies), 14, 143, 334, 335, 337, 405
- Capable, 9, 10, 20, 89, 141, 167, 249, 294
- Career, 6, 21, 49, 99, 123, 135, 154, 166, 172, 190, 203, 213, 224, 277, 301, 321, 347, 372, 392
- advancement, 9, 49, 55, 56, 168
- fair, 356
- planning, 168
- progression, 403
- Case, 4, 21, 67, 89, 122, 137, 166, 173, 188, 213, 222, 241, 255, 275, 293, 310, 322, 352, 378, 388
- court, 226
- dismissed, 270
- precedential, 256
- Caucasian, 350
- non-, 133, 135
- Caucus for Women in Statistics (CWS), 16, 178, 235, 326
- Causal, 261, 295
- Causal sequence, 296
- Cavell Brownie Scholars Program, 195, 196
- Celebrate, 100, 168, 317, 337, 360
- Celebration, 134, 176, 393, 396
- Center for Excellence in Universal Design, 244
- Centers for Disease Control and Prevention (CDC), 240
- The Centre Circle, 150
- Centre for Global Diversity, 150
- Chair, 11, 13, 16, 54, 114, 193, 205–207, 218, 242, 250, 275, 281, 301, 337, 343, 344, 350, 352, 354, 357, 362, 365–367, 372, 392, 395
- department, 54, 205, 207, 344
- Challenge, 11, 12, 14, 19, 21, 34–35, 39, 40, 48, 51, 52, 66, 67, 70, 75, 81, 82, 84, 91, 98–100, 107, 114, 117, 118, 136, 138–140, 143, 145, 148, 149, 153–155, 165, 167, 173, 175, 181, 198, 212, 227, 232, 240, 243, 244, 247, 252, 296, 300, 303, 314, 346, 351, 372, 379, 388, 389, 399, 401, 402, 405

- Challenging, 3, 5, 36, 38, 51, 65, 84, 114, 122, 135, 137, 160, 227, 313, 321, 322, 346, 395, 404  
 Champion, 189, 322, 367  
 Change, 3, 25, 31, 55, 82, 94, 107, 134, 156, 188, 208, 228, 241, 287, 296, 309, 329, 346, 355, 373, 394  
     management, 40  
     managing, 113  
 Character, 23, 90, 206, 207, 294, 297–299, 303, 315  
     main, 315  
     supporting, 315  
 Characteristics, 17, 37, 50, 51, 56, 117, 122, 124, 125, 132, 137, 138, 145, 147, 158, 159, 163, 179, 180, 197, 212, 256, 263, 268, 269, 278, 281, 285, 329, 337, 376, 387, 398, 404  
 Cheerlead, 337  
 Child care, 190  
 Chronicle of Higher Education, 4, 5, 278  
 Circuit, 32, 223, 258–261, 266  
 Circuit court, 226, 258, 269  
 Citizen, 5, 21, 221, 235, 283, 331, 374, 406, 407  
     informed, 305  
 Civil rights, 20, 24, 228, 234, 239–241, 251, 261  
 Civil Rights Act, 162, 172, 224, 229, 256, 261, 262  
 Claim, 95, 120, 124, 225, 227, 232, 255–259, 261, 265, 275, 295, 300  
 Class, 11, 24, 32, 67, 132, 167, 221, 232, 244, 261, 269, 270, 302, 316, 343–345, 349–351, 353, 382, 400, 401, 403  
 Class action, 232, 261, 270  
 Climate, ix, 5, 36, 54, 59, 156, 160, 188, 189, 200, 208, 279, 289, 343, 346  
     organizational, 14, 95–96, 122  
 Climate of organization, 14, 95–97, 124  
 Coach, 58, 144, 166–168  
 Coaching, 71, 140, 166–167, 176, 333, 335  
 Co-chair, 334, 350  
 Cognisance/cognizance, 96, 391, 407  
 Cognitive, 89–91, 93, 118, 121, 125, 179, 240, 378  
 Cognitively, 402  
 Co-lead, 144  
 Collaborate, 13, 31, 43, 59, 212, 365, 377, 394, 400  
 Collaboration, 12, 13, 23, 31–44, 47–60, 95, 105, 113, 137, 139, 141, 154, 197, 212, 215, 323, 361, 362, 373, 390, 391, 393, 399, 400, 402–405, 407  
     serial, 302  
     straight, 390  
 Collaborative learning, 67  
 Collaboratively, 14, 31, 42, 106, 403  
 Collaborators, 38, 48, 49, 52–55, 57–60, 149, 322, 330–332, 334, 336–338, 347, 365, 367, 379, 387, 398, 399, 401–404, 406, 407  
 Colloquy, 288  
 Color, 17, 23–25, 94, 159, 160, 162, 163, 172, 178, 206, 310, 314, 359, 366  
     people of, 160, 178  
 Commitment, 4, 5, 11, 14, 23, 75, 79, 94, 97, 133, 136, 150, 153–157, 160–161, 173–176, 178, 180, 199, 216, 312, 313, 332, 380, 394, 407  
 Committed, 16, 79, 115, 156, 158, 161, 189, 200, 226, 241, 317, 384  
 Committee, 4, 22, 59, 112, 149, 159, 170, 172, 187, 203, 218, 222, 242, 264, 275, 325, 350, 372, 394  
     tenure and promotion, 264  
 Committee of Presidents of Statistical Societies (COPSS), 4, 15, 16, 192, 363  
 Committee on Minorities in Statistics, 112, 196, 198, 350, 366  
 Committee on Statistics and Disability, 247, 252  
 Committee on Women in Statistics, 325  
 Commonality, 143, 145, 151, 232, 270, 399  
 Commonality requirement, 270  
 Common sense, 251, 341  
 Communicate, 8, 11, 51, 52, 91, 110, 112, 114, 137, 142, 154, 160, 161, 178, 296, 298, 301, 302, 304, 306, 311, 313, 316, 317, 323, 336, 346, 347, 352, 377, 379, 380, 382–383, 403  
 Communication, 33, 50, 52–56, 59, 60, 74, 75, 79, 89, 96, 107, 111, 112, 114, 135–137, 139, 141, 145, 155, 158, 167, 176, 178, 191, 200, 250, 296, 298, 301, 304–306, 330, 356, 387, 388, 391, 398, 399, 401, 403–407  
     science, 304  
     skills, 60, 137  
     styles, 75, 136  
 Community, 4, 21, 38, 69, 94, 134, 153, 168, 176, 187, 205, 214, 223, 240, 257, 275, 295, 310, 324, 347, 354, 374, 387  
 Comparator, 259, 265, 266, 269  
     hypothetical, 269  
 Compassion, 93, 94, 348, 391  
 Compassionate, 83  
 Compensate, 44, 167, 169, 267

- Compensation, 114, 141, 144, 193, 204, 233, 263, 281, 333
- Competence, 7, 52, 95, 174, 381
- Competency(ies), ix, 42, 52, 95, 174, 280, 309, 381, 387, 398  
     core, 52, 53, 55, 60  
     leadership, 107, 113–114, 332  
     technical, 174
- Competition, 8, 36, 52, 93, 163, 169, 212, 327, 338, 345, 354, 391, 399
- Competitive, 106, 171–173, 181, 356
- Competitive advantage, 172, 173
- Compromise, 59, 83, 251
- Conduct, 16, 22, 41, 49, 53, 54, 98, 107, 145, 150, 163, 175, 179, 180, 191, 192, 233, 266, 276, 279, 282, 286, 335, 363
- Conference Board of the Mathematical Sciences (CBMS) Survey, 275–290
- Conference Board of the Mathematical Sciences Survey of Undergraduate Mathematics Programs, 275
- Confidence, 51, 81, 109, 315, 333, 345, 353, 373, 382
- Confident, 77, 315, 382
- Confidential, 22, 34, 246
- Confidentiality, 40, 276
- Conflict, 23, 47–60, 70, 84, 99, 107, 108, 113, 136, 310, 390  
     management, 50, 52, 54, 59  
     resolution, 113, 310
- Conflict-of-interest, 9
- Confront, 21, 26, 75, 84, 173, 298, 301
- Confrontation, 75
- Congress, 155, 222, 224, 225, 236, 241, 268, 269, 334, 375, 377, 392, 393
- Connect, 79, 92, 93, 108–112, 114, 143, 148, 151, 178, 197, 295, 312, 376, 389, 394, 396, 404
- Connected, well-, 347
- Connecting, ix, 313, 330, 381, 387, 392–393, 396–398, 405
- Connections, 15, 37, 92, 107, 112, 114, 117–126, 149, 188, 211, 213–216, 231, 287, 297, 311, 383, 389, 396, 397  
     emotional, 310, 317  
     personal, 123, 310, 396  
     social, 92, 119
- Connectivity, 121, 125, 146  
     social, 125
- Consensus, 40, 154, 363  
     building, 288
- Consistent, 56, 74, 76, 77, 256, 261–264, 268, 328
- Constitution, 17, 160, 221, 235
- Constitutional, 222–223, 394
- Consult, 126, 170, 246
- Consultancy, 395, 401
- Consultant, 191, 192, 372, 395  
     statistical, 390, 399, 403
- Consultation, 52, 53, 58, 276
- Consulting, 52, 132, 147, 175, 195, 234, 306, 333, 360, 362, 365, 390, 399, 401–403
- Context, 54, 68, 91, 95, 97, 122, 124, 214, 217, 226, 227, 244, 246, 286, 288, 293–296, 299, 335, 347, 372, 388, 390, 392, 393, 396, 398, 399, 401, 403, 406, 407
- Conversational intelligence, 105–115
- Conversations, x, 6, 12, 19, 20, 26, 35, 54, 109, 110, 112, 135, 143, 145, 148, 160, 167, 190, 242, 249, 250, 288, 303, 311, 350, 356, 361, 367, 403  
     difficult, 54, 167
- Cooperate, 51, 93, 333
- Cooperation, 6, 35, 36, 42, 212, 235, 337, 393
- Cost(s), 14, 35, 40, 42, 68, 124, 150, 229, 239, 246, 252, 262, 264, 270, 298, 336, 372
- Council of Graduate Schools (CGS), 278, 286
- Counseling, 189, 310
- Courage, x, 20, 343, 373, 377, 381–382, 391, 394, 407  
     emotional, 377, 381–382
- Court, 222, 223, 225–232, 239, 241, 244, 255–260, 262–270, 344, 379  
     case, 226  
     decision, 225, 227, 256, 260
- Courtesy, 251
- Creative, 13, 60, 76, 94, 97, 98, 141, 243, 368
- Creativity, 71, 94, 95, 113, 144, 331, 335, 337, 346, 362, 368
- Credibility, 113, 256, 265, 305, 381
- Credible, 261
- Credit, 34, 43, 47–60, 81, 298, 299, 354
- Credit sharing, 50, 52–54, 57, 59
- Crisis, 65, 84, 297
- Criteria, entry, 351, 367, 368
- Croatian Review of Economic, Business and Social Statistics (CREBSS), 324, 327
- Croatian Statistical Association (CSA), 3, 324–325, 335, 336
- Cultural, 8, 14, 20, 26, 43, 58, 65, 74, 75, 95, 112, 134, 154, 156, 166, 171, 173, 176, 177, 181, 204, 208, 313, 315  
     competence, 7, 95  
     differences, 58, 74, 167, 180  
     intelligence, 14, 65–84, 391, 407  
     norms, 204  
     revolution, 341, 342, 344–347
- Culturally relevant, 312

- Culture, 3, 22, 35, 36, 51, 65, 94, 107, 133, 154, 167, 173, 188, 204, 289, 305, 311, 323, 347, 364, 379, 406  
 change, 3, 4, 14–16, 35–37  
 healthy, 177  
 toxic, 169  
 Curiosity, 14, 294, 347, 381, 391, 407  
 Curious, 294, 341  
 Customer, 131, 132, 173, 175, 243, 280, 391  
 Customer-centric, 132
- D**
- Damages, 20, 21, 170, 256, 266–267  
 Data, big, 36, 57, 118, 375, 387, 405  
 Data science, ix, 3–27, 36, 39, 40, 42, 57, 60, 114, 149, 153, 159, 173, 178, 181, 322, 336, 346, 347, 365, 375–376, 379, 380, 382, 387, 392, 393, 405–407  
 Daubert, 227, 228, 256, 268, 270  
 hearing, 270  
 motion, 268  
 review, 256  
 standard, 227  
 David, F.N., 3, 396  
 Dean, 6, 12, 114, 188, 190, 191, 194, 197, 200, 201, 205–207, 264, 350, 352, 354, 362, 366  
 associate, 12, 188, 200, 205, 354, 361  
 Decision, 13, 31, 37, 40, 41, 51, 53, 69, 71, 73, 94, 97, 121, 125, 126, 132, 133, 135, 137, 142, 144, 145, 150, 162, 169, 179, 180, 218, 222, 223, 225–227, 230, 232, 233, 255, 256, 260–263, 265, 266, 268, 269, 276, 287, 295, 296, 298, 299, 304–306, 314, 330, 336, 347, 374  
 making, 31, 41, 126, 133, 137, 144, 218, 233, 305  
 De facto, 226, 251, 258, 347  
 Defendant, 225, 227, 232, 233, 255, 256, 258–268, 270  
 Delegate, 73, 165, 337  
 Demographic, 16, 17, 25, 26, 107, 133, 134, 149, 166, 179, 180, 193–195, 212, 213, 279, 284, 285  
 Deny, 222  
 Denying, 262, 301  
 Devaluation, 279  
 Development, 9, 11, 33, 47–49, 52, 53, 55, 56, 60, 67, 69, 74, 75, 79, 92–94, 105–115, 118, 132, 134, 135, 140–143, 146–149, 155, 159–161, 167, 168, 175–178, 197–201, 218, 285, 289, 324, 331, 333, 347, 354, 372, 380, 387–404, 406  
 professional, 60, 148, 149, 161, 176, 199, 285, 333, 390, 398, 401  
 Dialectically, 297  
 Difference, 5, 8, 49, 54, 58, 70, 74, 75, 94, 95, 98, 100, 106, 107, 118, 123, 125, 132, 136, 142–145, 167, 168, 180, 192, 203–205, 208, 209, 223, 225, 226, 231–233, 242, 251, 257, 260, 263, 265, 266, 269, 280, 289, 294, 301, 312, 322, 332, 360, 376, 384  
 Different, 3, 21, 35, 48, 75, 95, 107, 119, 135, 158, 166, 177, 187, 207, 217, 240, 256, 293, 312, 321, 341, 350, 375, 391  
 Differential, 99, 124, 257, 258, 265, 269  
 Diffused, 388  
 Diffusion, 289, 388  
 Dimension, extra, 387, 388  
 Diplomacy, 75  
 Diplomatic, 390  
 Disability(ies), 16, 24, 132, 155, 172, 212, 223, 239, 255, 279, 300, 314  
 equality Index, 243  
 physical, 241, 250, 251, 314  
 Disability:IN, 243  
 Disable, 141, 156, 300  
 Disadvantages, 7, 11, 24, 25, 137, 138, 209, 255–270, 286  
 Disagree, 189  
 Disagreement, 52, 83, 246, 256, 264  
 Disciplinary, 51, 54, 58, 266, 300, 373  
 actions, 300  
 Discipline, 8, 49, 77, 118, 154, 174, 188, 208, 235, 269, 279, 300, 326, 346, 359, 372, 389  
 Disciplined, 300  
 Disconnection, 112–113  
 Discover, 37, 42, 110, 158, 321, 337  
 Discovery, 17, 47, 92, 110, 112, 115, 118, 262, 297–299, 302, 378, 397, 401, 404, 407  
 robust, 262  
 Discrimination, 9, 16, 83, 98, 142, 162, 204, 223–229, 232–237, 241, 248, 249, 255–270, 300  
 cases, 227, 232, 255–270  
 employment, 228  
 pattern of, 204, 269  
 positive, 233  
 Discriminatory, 9, 225, 226, 231, 233, 260–262, 265, 270, 300  
 non-, 231  
 Disparate, 226–228, 259, 260, 265, 268, 269, 312  
 actions, 312  
 impact, 226, 259

treatment, 226–228, 259, 260, 265, 268, 269

Disparity, 148, 193, 227, 231, 256, 258–264, 269, 270, 278, 280, 300, 312

Dissention, 380

District court, 255, 268

Distrust, 109, 111–113

Diverse, 3, 22, 31, 47, 68, 131, 153, 166, 173, 188, 212, 243, 276, 315, 329, 346, 350, 390

Diverse ideas, 346

Diversify, 147, 156, 197, 256, 270

Diversity, 4, 19, 50, 90, 107, 131, 153, 165, 171, 187, 211, 234, 240, 256, 275, 309, 336, 346, 349, 381, 389

Diversity, equity and inclusion (DEI), x, 4, 5, 12, 13, 15, 16, 18, 243, 311

Diversity & inclusion (D&I), 17, 150, 172–174, 176–178, 180, 309–317

Diversity Mentoring Program, 113, 178, 195, 196, 200, 366

Diversity officers, 5, 12

Dramatic, 283, 297, 303, 306

Dramatic arc, 297, 306

Drop out, 112, 212

Dropping out, 191

## E

Education, 4, 21, 34, 50, 65, 132, 159, 176, 192, 204, 214, 222, 241, 257, 278, 294, 312, 323, 344, 351, 373, 391

Education levels, 74–79, 204, 263, 324, 376, 390

Eligible, 68, 106, 142, 226, 267, 277, 285, 362

Elite, 302

Embracing, 4, 5, 50, 51, 54, 58, 314, 315, 355

Emmy Noether Lecture Series, 234

Emotion, 52, 89–94, 96–100, 106–109, 111, 113, 306, 312, 366, 368

Emotional, 52, 89–100, 105–109, 111, 113–115, 121, 123, 246, 296, 310, 317, 373, 377, 381

intelligence, 89–91, 97, 99, 100, 105–109, 113–115

needs, 111

skills, 89–100

Emotionally, 20, 95, 99, 113, 299, 402

Empathetic, 95, 337, 359

Empathetic concern, 95

Empathy(ize), 14, 89–101, 107–109, 112, 113, 124, 311, 330, 391, 404

Employee resource groups, 134, 136, 176

Empower, 14, 26, 218

Empowering, 20, 147, 313, 315, 329

Empowerment, 27, 406

ENAR Diversity Workshop, 178, 356, 357, 361, 362, 366

Encourage, 37, 66, 69, 71, 94–96, 105, 114, 134, 142–144, 146, 148, 151, 154, 169, 175, 177, 178, 187, 188, 197, 208, 218, 247, 252, 295, 311, 315, 317, 322, 337, 351, 354, 365, 368, 371, 378, 380, 389

Encouragement, 26, 96, 168, 322, 360

Encouraging, 72, 112, 114, 198, 208, 270, 329, 355, 371, 376, 397

Encyclopaedia of statistical science, 326

Energy(ize), 13, 39, 51–55, 79, 118, 122, 132, 217, 260, 312, 317, 329, 344, 348, 366–368, 380

Engage, 38, 41, 43, 50, 53, 54, 71, 93, 123, 134–136, 150, 156, 167, 168, 178, 181, 188, 288, 289, 295, 299, 304, 316, 337, 352, 354, 357, 365, 368, 379

Engagement, 70–73, 77, 78, 84, 94, 95, 97, 111, 135, 145, 147, 150, 156, 289, 304, 305, 310, 313, 314, 333, 334, 400, 406

Engaging, x, 52, 53, 55, 57–60, 76, 157, 178, 187, 296, 298, 302–304, 313, 382

Enrichment, 25, 252, 351, 397

Enthusiasm, 90, 122, 124, 305, 334

Enthusiastic, 335

Enthusiastically, 337

Entrepreneur, 100, 322, 328

Envious, 249

Environment, 4, 31, 49, 82, 91, 108, 118, 132, 153, 165, 175, 188, 211, 227, 239, 279, 311, 323, 355, 392

close-knit, 358

comfortable, 13, 126, 357, 359, 368

Envy, 249

Equal access, 222

Equal Employment Opportunity Commission (EEOC), 133, 230, 245, 256–258, 260, 264–268

Equality, 10, 95, 136, 173, 204, 208, 222–224, 229, 243, 332, 351, 380

Equal opportunity, 4, 7, 9–10, 15, 16, 153, 245

Equal pay, 163, 224, 225, 230, 256–259

Equal Pay Act (EPA), 230, 257, 259, 260, 267, 269

Equal pay for equal work, 163, 224

Equal protection, 223

Equal Rights Amendment (ERA), 222, 235

Equal work, 163, 224, 257, 260

Equitable, 3, 19–27, 207, 221, 311, 316



- Equity, x, 4, 9–11, 24, 174, 191–195, 199, 204–206, 208, 212, 221–236, 310, 311, 351, 362, 367, 377, 382  
 economic, 228
- Equivalent, 110, 224, 245, 258, 267
- Ergonomic, 244
- Ethical, 39, 121, 122, 125, 228, 236, 329, 337, 375, 376, 379, 380, 382, 391  
 practice, 228  
 standards, 329
- Ethics, 52, 90, 93, 143, 234, 333, 354, 358, 375–376, 380, 382  
 code of, 333
- Ethnicity, 7, 17, 21, 51, 132, 137, 143, 154, 155, 159, 194, 212, 243, 278, 279, 281, 285, 351
- European commission, 327
- European Courses on Advanced Statistics (ECAS), 325
- Evaluating, 57, 60, 100, 120, 149–151, 166, 175, 200, 265, 268, 313, 388
- Evaluation, 34, 42, 56, 60, 135, 144, 160, 166, 192, 224, 225, 261, 279, 377, 398, 401, 403  
 performance, 261, 403  
 system, 261
- Evidence, 13, 16, 22, 31, 35, 36, 39–43, 48, 89, 96, 99, 100, 104, 120, 123, 222, 226–229, 232, 236, 249, 252, 255–270, 287–289, 295, 299, 300, 312, 315, 332, 347, 377, 393  
 admissible, 260, 270  
 statistical, 224, 227, 255–270
- Evidence-based, 22, 35, 36, 100, 287–289, 377
- Example, 4, 20, 34, 48, 68, 90, 105, 117, 134, 154, 166, 174, 204, 211, 226, 243, 258, 295, 310, 330, 343, 354, 372, 389
- Execute, 18, 41, 70, 74, 332, 334
- Execution, 51, 134, 168, 227, 309, 313–317, 392
- Executive, 35, 39, 91, 106, 132, 153, 155, 161, 172, 176, 258, 304, 354, 380  
 committee, 353  
 order, 35, 39, 153, 155, 161, 172
- Exemplary, 300, 329
- Expectations, 22, 23, 25, 31, 33, 34, 54, 55, 58, 74, 107, 133, 136, 139, 141, 144, 158, 167, 177, 180, 209, 212, 241, 245, 249, 285, 321, 333, 399  
 societal, 321
- Experience, 5, 21, 36, 48, 70, 92, 105, 120, 132, 154, 166, 172, 194, 231, 239, 263, 279, 295, 310, 321, 347, 350, 374, 398  
 prior, 269
- Experienced, 7, 9, 49, 141, 142, 144, 170, 188, 241, 249, 301, 312, 314, 316, 337
- Expert, 33, 37, 81, 89, 100, 225, 228, 230, 234, 246, 256, 262, 263, 270, 322, 324, 327, 330, 333, 363, 371, 380, 381  
 testimony, 256, 270  
 witness, 225, 234, 316, 379
- Expertise, 35, 40–42, 44, 49–54, 56, 57, 107, 151, 172, 193, 223, 280, 305, 359, 363, 372, 380, 381, 383
- Exploit, 20, 22, 117
- Exploitation, 22, 23, 27
- Explore, 4, 19, 41, 96, 156, 157, 159, 161, 173, 175, 246, 247, 289, 297, 383, 401, 402
- Extraversion, 99
- F**
- Facilitate, 15, 58, 70, 91, 94–98, 100, 111, 121, 197, 206, 244, 389
- Facilitating, 3, 13, 310, 329, 403
- Fair, 51, 54, 59, 118, 120, 123, 135, 163, 166, 179–181, 204, 207, 225, 256, 260, 270, 328, 351, 356, 379  
 employment, 256  
 hearing, 256  
 witness, 379
- Fairness, 10, 17, 134, 136, 137, 141, 166, 233
- Faith, 335
- Fear, 52, 107–108, 111, 112, 142, 145, 244, 249, 338, 357
- Federation of European National Statistical Societies (FENStatS), 325
- Federation of European Statistical Societies, 335
- Feedback, 9, 15, 36, 43, 44, 57, 84, 135, 139, 150, 168, 178, 307, 363, 400
- Feelings, 12, 52, 59, 90–94, 98–100, 107–108, 111, 112, 120, 123, 134, 135, 142, 154, 225, 229, 249, 322, 335–337, 362, 396, 400
- Fellows, 49, 57, 151, 158, 199, 200, 233, 234, 242, 244, 325, 331, 344, 345, 352, 363, 364, 366, 392
- Fellowships, 9, 17, 20, 56, 190, 201, 324, 331, 352, 356, 397
- Female, 17, 23, 106, 123, 147, 148, 190, 191, 204–209, 213, 217, 222, 229, 230, 233, 234, 258, 259, 263, 264, 266, 267, 321, 329, 332, 336, 382, 392, 396
- Fiction, 301, 379
- Fictitious, 303
- Field of Dreams Conference, 178, 197, 214
- Find-a-Graduate Program web site, 278

Fire, 92, 170, 382  
 Firing, 92, 162, 262  
 First generation, 6, 7, 212, 350  
     college student, 6, 7  
     graduate student, 350  
     students, 212  
 Flexibility, 37, 75, 79, 91, 138, 140, 150, 247, 251  
 Flexible, 5, 11, 134, 138–142, 146, 147, 151, 154, 222, 337  
 Flexible work schedule, 134, 138, 140, 141  
 Florence Nightingale David, 15, 16, 363  
 Florida Georgia Louis Stokes Alliance for Minority Participation (FGLSAMP), 215  
 Focus groups, 150  
 Followers, 89, 90, 99, 122, 123, 322, 329–332, 337, 338  
 Fostering Diversity in Biostatistics (FDB), 350, 354–356  
 Foundations, 10, 35, 36, 51, 139, 143, 162, 197, 200, 280, 286, 327, 345, 350, 360, 372, 387, 392, 394, 396, 398, 402  
 Freedom, 70–72, 76–78, 84, 125, 300  
 Freedom of Information Act, 300  
 Functional MRI, 92  
 Future, 11, 33, 42, 48, 94, 100, 109, 115, 124, 136, 145, 156, 160, 173, 179, 180, 188, 215, 229, 275, 280, 287, 296, 302, 310, 315, 316, 333, 334, 338, 350, 351, 373, 379, 380, 387, 394, 396, 398, 399, 401–404, 406

**G**

Gallup Research Center, 324  
 Gay, 5, 188, 189, 279  
 Gender, 9, 22, 94, 132, 154, 169, 172, 188, 203, 212, 223, 243, 258, 276, 321, 347, 359, 379  
     balance, 276  
     conformity, 22  
 Gene promoter, 322  
 Genetic, 7, 56, 91, 162, 179, 322  
 Gentleman, 233–235  
 Gentlemen's agreement, 234  
 Geographic, 17, 135, 213  
 Giants, 387, 389, 392–393, 405  
 Gifted, 332  
 GLBT, 187–190, 199, 200  
 Global, 5, 6, 20, 23, 95, 131, 150, 171, 181, 330, 336, 391, 393, 394, 405, 407

Goals, 6, 37, 51, 72, 90, 108, 118, 136, 154, 168, 171, 198, 212, 224, 240, 276, 294, 313, 321, 347, 350, 408  
 Good  
     common, 329  
     organizational, 329  
 Governance, 35, 39–43  
 GPA, 212, 215, 218, 266, 356, 358  
 Grassroots, 20, 224, 312  
 Group, 5, 21, 40, 49, 70, 95, 106, 118, 132, 154, 166, 172, 187, 212, 228, 243, 259, 276, 312, 321, 341, 352, 383, 397  
     affinity, 134, 160, 187  
     cohesion, 96  
     projects, 212  
 Guarantee, 221–223, 226  
 Guidance, 35, 39, 56, 75, 110, 198, 226, 241, 246, 321, 331, 350, 364, 368, 379  
 Guideline, 17, 43, 75, 158, 176, 246, 256, 266, 300  
 Guiding, 39, 187, 321, 328, 379

**H**

Happiness, 346  
 Happy, 235, 242, 316, 344, 348, 351  
 Harassment, 9, 15, 16, 22, 224, 279  
 Hardship, 139, 241, 245, 251  
     undue, 139, 241, 245, 251  
 Hard-working, 147, 350  
 Harmony, 52, 310, 394  
     racial, 310  
 Healthy, 4, 107, 108, 113, 118, 125, 174, 177  
 Heartland Mathematics Partnership, 214  
 Hero, 297, 366  
 Heroes, anti-, 297  
 Heterogeneous, 51, 94  
 Heteronormativity, 21  
 Heterosexual, 189  
 Hierarchical, 75, 391  
 Hierarchy, 35, 51, 74, 75, 329  
 Higher Education Research Institute, 286  
 Hire, 44, 114, 138, 155, 158, 166, 171, 173, 177, 178, 192, 213, 245, 246, 266, 267, 270, 283, 286  
 Hiring, 44, 133, 137, 138, 141, 142, 151, 155–159, 161, 162, 172, 179, 208, 233, 246, 259, 262, 277, 282–283, 299, 313  
 Hiring Practices, 42, 156, 208  
 Hispanic, 134, 150, 155, 156, 176, 178, 352  
 Hispanics and Native Americans in Science, 178  
 Historically black college, 349

- Historically black colleges and universities (HBCU), 150, 166, 196, 217, 349, 356, 359, 360, 368
- Historically underrepresented, 12, 173, 177, 178, 198, 199, 279
- History, 20, 66, 79, 117, 121, 134, 195, 239–241, 266, 295, 345, 376, 393, 395–397, 406
- Holy grail, 315
- Homogeneous, 173, 263
- Homophobic, 169
- Hook, 298
- Hope, 4, 91, 98, 105, 161, 199, 212, 213, 276, 278, 297, 298, 310, 384
- Human
  - capital, 171, 172, 243
  - right, 82, 243
  - tendency, 404
  - welfare, 388, 389, 392, 407
- Humanistic, ix, 91, 276, 322, 326, 330, 354, 355, 360, 362, 364, 366–368, 387, 389, 391, 392, 404
- Humanitarian, 66, 94, 331
- Humanity, 324, 331, 404
- Human resources (HR), 11, 112, 135, 141, 142, 156, 161, 165, 170, 172, 175, 176, 193, 246, 352
- Humiliate, 83
- Humility, 14, 105, 154
  - cultural, 154
- Humor, 89–100
  - sense of, 89, 92, 94, 96–98
- I**
- Identifies, 4, 14, 25, 37–40, 43, 50–53, 57, 70, 71, 107, 108, 124, 135, 143, 145, 150, 158, 172, 175, 178, 208, 225, 233, 243, 252, 259, 279, 297, 354, 356, 362, 363, 382, 389, 391, 392, 394, 396, 401
- Identity(ies), 5, 7, 16, 25, 92, 95, 154, 159, 189, 257, 329, 336, 387, 388, 406
- Imaginations, 12, 244, 251, 275–290
- Immigrants, 21, 24
- Impactful, 48, 55, 134, 144, 313, 316
- Impacts, 22, 26, 39, 41, 74, 98, 107, 131, 133, 135, 137, 138, 141, 145, 150, 156, 158, 159, 169, 175, 181, 188, 196–201, 221, 226–228, 242, 246, 248, 249, 251, 259, 287, 301, 310–312, 314–316, 328, 331, 371, 372, 378, 393, 402, 404, 405
- Impairments, 11, 240, 245, 246, 248, 250
  - auditory, 246
  - visual, 248, 250
- Impartiality, 379
- Imposter syndrome, 358, 359
- Improves, 36, 53, 66, 73, 77, 112, 114, 150, 155, 163, 169–171, 175, 312, 321, 323, 330, 332, 334, 336, 337, 354, 388
- Incentives, 36, 44, 124, 188, 256, 260, 281, 304
- Incident, inciting, 297, 302
- Inclusion, x, ix, 4–8, 11–14, 16, 17, 19, 21, 26, 114, 132–137, 142–147, 149–151, 153–163, 171–181, 187, 188, 200, 201, 212, 232, 233, 239–252, 275, 279, 286, 289, 309–317, 329, 347, 354, 358, 367
  - full, ix, 239, 240
  - index, 149, 150
- Inclusion Study, 279, 286
- Inconsistent, 232, 267, 313
- Independence, 72, 235, 341–348
- Inequality, 222, 279, 375
- Infinite Possibilities Conference, 366
- Influence, 13, 15, 20, 43, 51, 92, 110, 113, 122, 132, 133, 144, 163, 171, 174, 178, 179, 188, 248, 288, 289, 314, 330–333, 335, 337, 338, 366, 384, 390, 392, 394, 404
  - influential, 26, 187, 331, 376
  - positive, 384
- Inform, 36, 176, 217, 280, 289
- Information, 31–34, 40–42, 44, 51, 57, 58, 68, 84, 90, 100, 109, 110, 117, 119, 121, 125, 129, 143, 146, 151, 155, 158, 162, 163, 179, 193–195, 199, 240, 243, 252, 264, 269, 276–278, 281, 282, 286–288, 294, 297–302, 305, 306, 323, 336, 383, 388, 401, 405, 406
- INFORMS Transactions on Education, 69, 77–79
- Initiatives, ix, 16, 24, 25, 65–67, 69, 77, 79, 84, 136, 140, 144, 150, 153–156, 159, 187–201, 243, 246, 295, 304, 312, 314, 332, 335, 354, 365, 371, 402
- Injustice, 311, 314
- Innovate, 50, 54, 381, 392
- Innovation, 5, 12, 26, 37, 55, 67, 94, 131, 132, 173, 175, 281, 346, 389, 394, 396
  - media, 306
- Innovative, 37, 66, 71, 132, 150, 154, 155, 158, 243, 247, 337, 371, 378, 379, 397
- Innovator, 48, 132, 396
- Insecurity, 52, 96
- Insightful, 48
- Insights, 19, 35, 42, 48, 55, 72, 81, 117, 120, 134–136, 149, 150, 168, 170, 176, 195, 279, 281, 295, 302, 316, 330, 331, 352, 357, 360, 361, 366, 368, 392, 395

- Inspirational, 122, 359, 387, 389, 392–393, 395
- Inspirations, 51, 81, 122, 199, 234, 331, 338, 389, 391
- Inspire, 94, 97, 122, 296, 301, 332
- Inspiring, 65, 72, 113, 147, 329, 337, 347, 384, 389, 397, 400
- Institute for Mathematical Statistics (IMS), 17, 281, 290, 347, 372, 373, 392
- Institute of Social Research, 331
- Insurance, 162, 191, 228–231, 247, 255, 270, 299
  - disability income, 247
  - health, 162, 191, 231, 247
  - life, 229
- Integrate, 50, 60, 133
- Integrated Postsecondary Education Data System (IPEDS), 21, 278, 286
- Integrated team, 337
- Integrative thinker, 381
- Integrative thinking, 381
- Integrity, 5, 163, 329, 379, 407
- Intellectual, 44, 56, 93, 107, 122, 280, 331, 341, 346, 347, 359, 376
- Intelligence, cultural, 14, 65–84, 391, 407
- Intelligence quotient (IQ), 89, 90, 107
- Intend, 13, 35, 38, 41, 132, 228, 251, 259, 268, 307, 362
- Intent, 59, 98, 218, 239, 261, 268, 313
- Intentional, 13, 21, 27
- Intentionality, 251
- Interact, 35, 73, 75, 83, 90, 122, 165, 200, 240, 244, 295, 305, 363
- Interactions, 15, 31, 35, 37, 52, 53, 90–93, 96, 120, 121, 123–125, 145, 146, 179, 197, 209, 250, 251, 359, 398
- Inter American Statistical Institute, 394
- Interconnect, 51, 92, 105
- Interests, 7, 9, 12, 17, 20, 32, 38, 39, 49, 52, 68, 96, 118–120, 123, 125, 134, 138, 142, 146, 154, 159, 160, 163, 168, 169, 190, 196, 199, 204, 213, 215, 223, 229, 233, 234, 240, 264, 276, 277, 300, 302–304, 309, 316, 322–326, 329–331, 334, 336, 341, 356–358, 360, 362, 365, 380, 381, 383, 389, 393, 395, 397, 399
- Intern, 352, 365
- International Association for Statistical Education (IASE), 325, 395
- International Association for Survey Statisticians (IASS), 325
- International Biometric Society (IBS), 16, 178, 355, 392
- International Labour Office and Economic Committee, 394
- International Prize in Statistics (IPS), 392
- International Statistical Commission, 393
- International Statistical Conference in Croatia (ISCCRO), 325, 326, 335
- International Statistical Institute (ISI), 3, 16, 17, 325, 375, 392–395, 404
- Internship, 60
- Interpersonal, 79, 84, 89, 90, 94, 96, 98, 121, 123
  - communication, 89, 96
  - interaction, 120
- Intersectional, 24–27
- Interuniversity Seminary of Mathematical Sciences Research in Puerto Rico (Seminario Interuniversitario de Investigación en Ciencias Matemáticas (SIDIM)), 215
- Interview, 15, 158, 172, 179, 180, 213, 215, 245, 300, 363
  - structured, 180
- Interviewers, 158, 179, 180
- Interviewing, 15, 172, 179–180, 352
- Intrapersonal, 90
- Introvert, 142
- Invaluable, 365, 388, 393, 394, 403
- Invest, 105, 147, 150, 178, 217, 349
- Invested, 172, 230, 375
- Investigation, 56, 57, 118, 191, 293, 294, 297, 302, 304, 341, 401–406
- Investment, 115, 175, 316
- Invisibility, 52
- Invisible, 388
- Invitations, 23, 148, 322, 363, 372, 373
- Invite, x, 178, 310, 366, 383
- Inviting, 22, 145
- Iowa Summer Institute of Biostatistics (ISIB), 213–215
- Ipsos Croatia, 327
- ISI Committee on Women in Statistics (CW-ISI), 16, 325
- ISI Education Committee, 394, 395
- Isolated, 125, 135, 169, 270, 305
- Issues, 5, 13, 14, 41, 52–54, 67–69, 74–78, 81, 89, 112, 118, 119, 122, 125, 138, 145, 148, 149, 151, 153, 158, 159, 176, 187, 189–192, 222, 224, 227, 230, 234, 236, 239–242, 245, 248, 249, 256–260, 262, 265, 266, 268, 269, 286, 309–312, 322–324, 330, 373, 375, 376, 379, 400, 401

**J**

Jeopardy, 299  
 Job Accommodation Network (JAN), 246  
 Joint Statistical Meetings (JSM), ix, 3, 8, 15,  
 16, 19, 24, 113, 195–196, 200, 213,  
 298, 353, 363, 366, 378, 379  
 Journalism, 296, 300  
 Journalistic, 293, 300  
 Journalists, 275, 293, 295, 299, 300, 304, 382  
 investigative, 295  
 Journeys, x, 43–44, 175, 196, 297–299, 302,  
 311, 312, 315–317, 330, 349–368, 397,  
 398  
 hero's, 297  
 Judges, 9, 136, 226, 228, 232, 233, 256, 261,  
 262, 264, 267, 268, 270, 344  
 Judgment, 14, 90, 256, 258, 265, 268–270,  
 288, 347  
 Junk science, 228, 270  
 Jury, 226, 227, 250, 255, 261, 265, 267, 270,  
 327

**K**

Karl Pearson, 328

**L**

Language, 5–7, 20–22, 57, 112, 137, 138, 158,  
 167, 180, 245, 302, 314, 322, 344, 347,  
 351  
 body, 180, 314  
 Latino/a, 12  
 Latinx, 5, 194, 196, 200  
 Laws, 7, 24, 34, 39–41, 155, 156, 162–163,  
 177, 221–223, 225, 226, 228, 230, 234,  
 236, 240, 241, 246, 247, 257, 258, 261,  
 262, 327, 379, 394  
 Lay audience, 305  
 Lead, 12, 26, 36, 42, 52, 55, 65, 74–76, 80, 83,  
 95–98, 111, 119, 120, 122, 132, 138,  
 140, 144, 146, 147, 160–161, 166, 168,  
 172, 174, 179, 187, 190, 212, 252, 288,  
 293, 296, 300, 309, 323, 328, 330, 332,  
 334, 335, 337, 338, 349, 350, 353, 360,  
 363, 366, 371, 373, 379, 384, 387, 388  
 Leaders, 4, 24, 37, 48, 66, 89, 106, 122, 135,  
 153, 170, 172, 187, 218, 275, 296, 309,  
 321, 347, 349, 371, 391  
 future, 188, 350  
 potential, 349, 367  
 thought, x, ix, 15, 371–384  
 unintentional, 322

Leadership, 4, 8, 13–16, 19–27, 36–43, 47–60,  
 65–84, 89–98, 105–107, 113–115,  
 117–126, 131–151, 156, 159–161, 165,  
 169, 171, 175, 176, 187–201, 236,  
 287–289, 296, 313, 316, 321–323,  
 328–338, 347, 349–372, 377, 383,  
 387–407  
 development, 134, 159, 160, 199–201, 372  
 humanistic, ix, 322, 330, 354, 355, 362,  
 366–368, 391, 392, 404  
 inspirational, 387, 389, 392–398  
 laissez-faire, 71, 329  
 productive, 404  
 pseudo-transformational, 329  
 skills, x, 107, 113, 114, 323, 330, 377  
 statistical, ix, 51, 53, 54, 60, 330–332,  
 388–391, 393–396, 398–407  
 styles, 60, 65, 70–73, 76–79, 96, 122–125,  
 133, 363, 388  
 transactional, 329  
 transformational, 72, 97, 122, 123, 125, 329  
 Leading, ix, 3, 26, 31–44, 65, 68, 83, 84, 90,  
 113, 140, 155, 156, 160, 165–170, 189,  
 232, 278, 296, 302, 315, 321–323, 327,  
 328, 330–332, 334, 336, 337, 374, 389,  
 392, 399, 405, 406  
 League of Nations, 393  
 Learn, 12, 41, 51, 58, 59, 77, 80, 113, 114,  
 123, 149, 157, 166, 174, 178, 214, 235,  
 250, 262, 288, 296–298, 304, 306, 311,  
 314, 329, 337, 355–357, 375, 380–383,  
 401–403  
 Learning opportunities, 84, 155, 156, 158, 159,  
 175  
 Leave, 13, 20, 134, 141, 143, 146, 150, 162,  
 190–192, 199, 200, 206, 208, 223, 225,  
 262, 296, 342, 357, 367, 397  
 family, 191, 208  
 parental, 190–191, 199, 200  
 Lectureships, 17  
 Legal, 84, 148, 170, 177, 226, 228, 232, 235,  
 241, 243–246, 251, 252, 255–270, 300  
 procedurees, 255  
 protections, 235  
 standing, 241, 244  
 system, 235, 255–270  
 Legality(ies), 239  
 Legally, 239, 245, 247, 252  
 Legislation, 224–225, 228, 236, 239, 377  
 Legislature, 231, 236, 305  
 Lens, 119, 300  
 social, 300  
 Lesbian, 24, 25, 188, 189, 279

- Lesbian, gay, bisexual, transgender (LGBT), 16, 134, 161, 189
- Lesbian, gay, bisexual, transgender, and queer (LGBTQ), 16, 24, 26, 132, 134, 135, 142, 153, 154, 156, 160, 176, 279, 314
- Leverage, 35, 52, 71, 132, 133, 136, 139, 141, 144, 145, 172, 289, 311, 402
- Leveraging, 36, 50, 51, 56, 135, 136, 155, 171, 314
- Liberal arts college, 5, 204, 215
- Lilly Ledbetter Fair Pay Act, 225
- Linkage, 42, 387
- Lip-reads/lip-reading, 250
- Listen, 12–14, 52, 59, 84, 109, 112, 126, 154, 288, 337, 390, 399
- Listening, 13, 32, 50–55, 110, 288, 357, 359, 390, 398, 399, 401, 404, 407  
active, 50–55, 390, 398, 399, 401, 404, 407
- Literacy, 133, 304, 323, 327, 330, 364, 373–324, 376, 380, 406  
statistical, 304, 324, 327, 330, 363, 373, 374, 376, 406
- Literate, 373, 380
- Litigation, 224, 225, 227, 229, 230, 232, 261, 267  
discrimination, 225
- Lobby/lobbying, 224, 225, 228, 231
- London Statistical Society, 393
- M**
- Magazine, x, 5, 21, 153, 161, 302, 303, 381
- Magnetic resonance imaging (MRI), 92, 117
- Male dominance, 234
- Management, 11, 35–37, 39–43, 48, 52–55, 57, 59, 60, 67–69, 75, 77, 90, 91, 93, 107–108, 112, 113, 121, 124, 140, 141, 145, 146, 150, 154–156, 161, 163, 165, 168, 175, 176, 290, 315, 325, 365
- Managers, 9, 36, 39, 40, 97, 98, 131, 133, 135, 136, 138–145, 150, 151, 156, 158, 159, 165, 167–170, 172, 258, 333, 344
- Managing, 37, 39, 74, 99, 113, 136, 138, 148, 154, 161, 165–170, 200
- Marginalize, 12, 166
- Marketing, 177, 178, 323, 324, 327, 333
- Markets, 34, 131, 133, 135, 194, 204, 229, 233, 234, 280, 281, 321, 322, 327, 333, 338, 342, 372, 388, 391  
forces, 194, 204, 233, 280, 333
- Marginalization, 279
- Matched pairs, 263, 265
- Math Alliance, 178, 196–198
- Mathematical and Statistical Sciences Annual Survey, 275, 276, 281
- Mathematical Association of America (MAA), 281
- MathX, 397
- Meaning, 23, 75, 112, 118, 239, 244, 278, 293–295, 305, 402, 403, 407  
search for, 293
- Meaningless, 293
- Mellon Mays Undergraduate Fellowship Program (MMUF), 352, 353, 358–360, 366, 368
- Mentees, 13, 113, 197, 347, 350, 351, 356, 364, 366, 368, 403
- Mentor, 12, 13, 15, 22, 23, 58, 113, 144, 195–197, 212, 213, 215, 331, 334, 335, 337, 338, 351, 356, 357, 360, 364, 366, 403  
peer, 356, 359–361
- Mentored, 6, 25, 60, 324, 334, 335, 403
- Mentoring, ix, 6, 12, 53, 54, 113, 134, 135, 159, 166–167, 176, 178, 187, 195–197, 200, 218, 236, 323–324, 330, 334–335, 361, 362, 364, 366, 391, 396, 403, 404
- Mentorship, 214, 331, 335, 346, 350, 364
- Merit, 50, 136, 155, 162, 163, 209, 225, 232, 248, 250, 257, 258  
system, 155, 162, 163, 257, 258
- Messages, 6, 80, 89, 110, 133, 176, 201, 212, 218, 233, 234, 288, 374, 383, 387, 402  
hypocritical, 402
- Messaging, 136, 176
- #MeToo, 20–21
- Micromanaging, 169
- Minds, 20, 42, 84, 90, 91, 98, 111, 119, 121, 158, 232, 240, 243, 276, 288, 303, 304, 317, 332, 335, 341, 343, 345, 375
- Mindset, 14, 142, 311, 375
- Minorities, 13, 15, 16, 20, 25, 26, 106, 112, 169, 173, 177, 178, 194–200, 206, 213–216, 224, 243, 248, 259, 261, 263–265, 270, 283, 286, 288, 350, 364–366
- Minority-majority pairs, 263
- Minority-serving institutions, 199, 215, 216
- Mirror neuron, 92, 93, 124
- Mission, 5, 16, 18, 39–41, 80, 81, 115, 131, 136, 159, 161, 175, 313, 379, 394, 404, 406
- Misunderstanding, 74, 76, 77, 158, 228, 406
- Mobility, 10, 241, 248, 250, 252  
limited, 248
- Modeled acceptance, 316
- Model of understanding, 295, 298, 306

- Models, 12, 17, 38, 40, 48, 49, 52, 59, 90, 91, 93–95, 99, 114, 118, 119, 122–124, 136, 138, 144, 149, 151, 154–156, 176, 190–194, 198, 200, 205–210, 224, 227, 231–233, 261, 280, 281, 288, 295, 298, 306, 315, 328, 335, 373, 388, 398, 399  
 business, 280  
 statistical, 42, 118, 119, 123, 124, 205–206, 374
- Monitor, 32, 54, 59, 90, 108, 139, 169, 212, 250
- Moral, 90, 95, 98, 304  
 obligation, 304
- Morales, 81, 361
- Morally, 239, 245
- Motions, 255, 256, 268
- Motivate, 38, 40, 93, 94, 97, 105, 108, 329, 332
- Motivating, 81, 269, 334, 335, 375
- Motivations, 71, 79, 108, 109, 122, 131, 135, 156, 241, 280, 388, 402
- Multicultural, 75, 83, 95, 143, 195  
 awareness, 143  
 competence, 95
- Mystery(ies), 298, 299, 302, 341, 373
- N**
- Narrative, 171, 293–317, 347
- Narrative structure, 297, 298
- National Academies of Sciences, 375
- National Alliance for Mathematical Sciences, 213
- National Centers for Educational Statistics (NCES), 278, 286
- National Council of Negro Women, 354
- National Diversity in STEM Conference, 178
- Nationality, 17, 212, 217, 351
- National Medal of Science, 376
- National Science Board (NSB), 286
- National Science Foundation (NSF), 190, 200, 213, 214, 276, 279, 286, 344, 372
- Negotiate, 82, 108, 154, 206, 336, 366
- Negotiation, 246
- Nepotism, 9
- Network, 11, 22, 32, 36, 51, 54, 91, 120, 121, 124, 125, 134, 147–149, 160, 197, 213–217, 244, 247, 336, 353, 365, 377, 381, 383
- Networking, 50, 60, 195, 327, 333, 377, 381, 383, 390, 398, 399, 401, 404
- Neural, 92, 93
- Neuroimaging, 117–121, 124, 125
- Neuroleadership, 125
- Neurologically, 91, 121
- Neuron(s), 92, 93, 118, 119, 124
- Neuroscience, 117–126, 347
- Nobel Peace Prize, 82, 326
- Nobel Prize, 326
- Non-Judgmental, 134
- Non-negotiable, 313
- Norms, 9, 15, 95, 98, 188, 204, 399, 400  
 gender, 9, 204
- NSF Advance, 190, 200
- NSF STEM Inclusion Study, 279
- NSF Vertical Integration of Research and Education in the Mathematical Sciences, 214
- Nurture, 84, 178, 214, 215
- O**
- Objective(s), 13, 17, 34, 38, 39, 50, 53, 69–76, 79, 81, 82, 121, 150, 154, 159, 161, 172, 179–181, 215, 240, 279, 280, 284, 303, 313, 381, 392, 394, 402
- Objectivity, 379
- Obstacles, 70, 82, 167, 190, 297
- Office of Disability Employment Policy (ODEP), 243, 244, 246, 249
- Office of Federal Contract Compliance (OFCCP), 256
- Office of Naval Research (ONR), 372
- Onboarding, 172
- Open, 3, 5, 9, 14, 20, 35, 54, 55, 59, 65, 91, 95, 109, 110, 134, 145, 147, 148, 150, 151, 154, 156, 163, 189, 198, 208, 214, 234, 244, 260, 299, 310, 311, 317, 331, 334, 347, 356, 357, 359, 363, 364, 396
- Openly, 5, 23, 35, 75, 148, 242, 315, 336, 361
- Open-minded, 5
- Openness, 95, 96, 251, 336
- Opportunity(ies), 4, 22, 34, 56, 65, 90, 111, 126, 133, 153, 168, 171, 192, 212, 221, 240, 256, 279, 296, 312, 324, 349, 372, 393  
 lost, 280
- Optimism, 99, 108
- Optimistic, 23, 60, 113, 384
- Organizational behavior, 89, 121
- Organizational culture, 14, 35–36, 39, 113, 149, 313
- Organizational structure, 156, 313
- Organizational systems, 313
- Organize, 39, 40, 66, 79, 149, 172, 178, 234, 236, 242, 334, 360, 362, 368
- Organizer, 322
- Outreach, 134, 135, 166, 175, 364, 387, 398, 405

- Over-achieving, 352  
 Ownership, 10, 47, 94, 150, 168, 170, 396, 397
- P**
- Paper, scientific, 298, 301, 302  
 Partner, 134, 209  
 Partnership, 6, 52, 67, 109, 196, 197, 214, 388  
 Part-time, 138, 139, 141, 146, 147, 193, 213, 225, 246, 277–278, 285  
 Passion, xx, ix, 82, 188, 311, 334, 337, 350, 352–354, 356, 359, 366, 368, 375, 377, 380  
 Passionate, 25, 188, 349, 350, 353, 359, 376, 377, 380  
 Paternalistic, 249  
 Path, 8, 50, 58, 59, 65, 74, 75, 84, 119, 154, 196, 312, 324, 332, 337, 346  
 Pathways, 57, 244, 248, 280, 396, 397  
   professional, 280  
 Patience, 51, 288, 316  
 Patient, 250, 348  
 Patronizing, 229, 248  
 Pay gap, 203, 204  
 Payoff, 316  
 Peer departments, 276  
 Peers, 106, 122, 138, 142, 144, 145, 147, 206, 349, 359  
 Penetration, 402, 405  
 Pension plan, 228–230  
 Pensions, 228–231, 300  
 Perception, 14, 50, 52, 96, 134, 135, 174, 208, 241, 242, 249, 252, 297, 301, 335  
   public, 241  
 Performance, 14, 23, 96, 98, 113, 135, 136, 139, 142, 144, 150, 161, 163, 167, 169, 176, 177, 180, 233, 245, 257, 261, 262, 296, 312, 316, 336, 345, 358, 403  
 Performance evaluation, 261, 403  
 Performance evaluation system, 261  
 Persevere, 16, 377  
 Persisted, 316  
 Persistence, 288  
 Personality, 51, 54, 58, 74, 83, 84, 94–96, 98, 111, 142  
 Perspective, 5, 8, 12–14, 19, 26, 37, 56, 58, 65, 70, 93, 99, 109, 111, 121, 122, 126, 131–151, 153, 177, 181, 193, 212, 281, 285, 302, 316, 322, 334, 361, 371, 381, 383  
 Pipeline, 119, 173, 177, 178, 211–218, 280, 287, 350, 367, 382  
   training, 280, 287  
 Pipeline maintenance, 211, 216–217
- Plaintiff, 224, 225, 232, 255–270  
 Policies, 9–11, 16, 27, 39, 40, 59, 112, 133, 134, 136, 145, 150, 155, 172, 176, 188, 208, 243, 244, 262  
   open door, 356  
 Policy maker, 35  
 Political action, 236  
 Political views, 212  
 Pool, candidate, 136  
 Popular, 89, 118, 148, 180, 198, 302, 349, 397  
 Popularize, 198, 302  
 Positive, 9, 15, 37, 42–44, 77, 80, 83, 89–91, 93–98, 108, 110, 118, 120, 123, 124, 143, 144, 146, 170, 179, 213, 226, 232–234, 242, 249, 250, 279, 296, 313, 316, 321, 361, 366, 377, 384, 390, 393  
 Positivity, 94, 360  
 Potential, 21, 24, 26, 54, 71, 74, 79, 81, 98, 100, 109, 118, 121, 123, 124, 132, 136, 137, 141, 142, 154, 157, 158, 172, 175, 180, 197, 217, 218, 228, 229, 239, 245, 247, 252, 262, 263, 265, 266, 269, 279, 296, 299, 312, 321, 322, 330, 331, 336–338, 349–351, 359, 363, 367–368, 397, 399, 404  
   full, 132, 252, 321, 338, 351, 367, 368  
 Power, 12, 14, 19–27, 34, 38, 42–44, 52, 72, 93, 95, 136, 144, 147, 160, 206, 208, 218, 224, 226, 228, 229, 232, 259, 261, 264, 286, 293–298, 302, 306, 309–317, 329, 331, 397, 400, 406  
 Practical intelligence, 91  
 Predicted status, 264  
 Predictors, 95, 205, 259, 262, 263  
 Pregnancy, 162, 223, 251  
 Pregnancy Discrimination Act, 162  
 Pregnancy leave, 223  
 Preliminary motion, 256  
 President, ix, 3–5, 14–16, 35, 80–84, 90, 112, 114, 153, 155, 159, 172, 192, 225, 234, 242, 324–326, 335, 337, 338, 347, 353, 354, 356, 359, 363, 365, 366, 371, 375, 376, 379, 383, 392, 394  
 Prestige, 203, 204, 231, 280  
 Pretext stage, 261  
 Prima facie, 226, 257, 259, 260, 265, 267–269  
 Principles, 16, 17, 39, 79–83, 136, 137, 155, 156, 159, 162–163, 228, 235, 236, 256, 263–266, 331, 332, 334, 337, 341, 342, 347, 373, 377, 379–381, 400, 403  
 Priorities, 39, 50, 107, 150, 168, 179, 218  
 Privilege, 19–27, 114, 221, 314, 315, 335  
   male, 314  
   white, 314



- Probativeness, 262  
 Problem solving, 39, 41–44, 51, 143, 145, 180, 402, 403, 405  
 Problems, solve, 243  
 Pro bono, 236  
 Process, 5, 7, 18, 39, 50, 59, 65, 75–79, 110, 112, 115, 117, 137, 148, 154, 156–159, 162, 171–173, 175–184, 187, 193, 196, 211, 221, 222, 232, 233, 236, 241, 245–246, 256–260, 267, 270, 297, 298, 302, 303, 305, 309, 310, 315, 317, 341, 360, 401, 402, 405, 406  
 Processes, 41, 43, 48, 53, 59, 77, 91, 92, 115, 117–119, 123, 124, 137, 150, 179, 180, 276, 313, 330, 334, 388, 397, 401  
 Production, 34, 41, 76, 154, 197, 257, 260, 276, 280–282, 305, 330  
 Productivity, 23, 58, 95, 135, 138, 140, 208, 258, 259, 353  
 Productivity factors, 258  
 Profession, ix, 3–19, 59, 60, 106–108, 113, 115, 147, 153, 174, 234, 235, 242, 247, 252, 275–290, 309, 310, 316, 317, 321, 323, 328, 331, 334, 337, 345, 354, 362–364, 381, 388, 389, 391, 393, 404  
 Professional associations, 8, 11, 16–17, 58, 156, 159–160, 287  
 Professional organizations, 159, 178, 276, 278–280  
 Professional societies, 66, 240, 373, 383, 404–405  
 Programs, 4, 6–9, 12, 22, 25, 34, 38–42, 51, 56, 57, 60, 95, 133, 134, 136, 146, 147, 149–151, 155–157, 162, 172, 176, 190, 195, 197–201, 211–215, 218, 247, 276–278, 281–285, 287, 312, 350–354, 356–362, 365–368, 380, 397, 398, 400, 403  
     executive development, 380  
 Progress, 3, 12, 23–26, 41, 51, 54, 91, 133, 150, 151, 176–178, 197, 212, 218, 309, 310, 314–316, 322, 378, 388  
     measure, 310, 315, 316  
     sustained, 315  
 Project(s), 5, 6, 9, 38, 41, 42, 48–55, 57–60, 67, 76, 77, 111, 114, 132, 136, 138–141, 144–146, 167, 168, 175, 190, 195, 200, 212–214, 229, 234, 242, 275–278, 285, 286, 289, 296, 305, 314, 321, 327, 330, 333, 335–338, 347, 352, 365, 367, 376, 379, 390, 396, 397, 401, 406  
 Project Implicit, 175  
 Promote, 4, 18, 20, 23, 27, 91, 100, 107, 112, 114, 115, 124, 133, 134, 136–138, 142, 145, 151, 154–156, 188, 192, 199, 200, 236, 262, 264, 289, 310, 323, 332, 334, 336, 337, 349, 366, 374, 377  
 Promoter, 322  
 Promoting, 94, 114, 135, 138, 144, 151, 155, 168, 177, 178, 190, 198, 200, 230, 289, 313, 324, 332, 373, 395  
 Promotion, 5, 17, 23, 55, 59, 114, 135, 148, 162, 168, 192, 201, 207, 226, 232, 233, 242, 247, 259, 261, 263–265, 267, 367, 373, 393, 394  
 Pronouns, 21, 22, 160, 167  
 Propaganda, 295  
 Protected categories, 224  
 Protected group, 260, 261, 269  
 Psychodynamic, 248, 249  
 Public, 7, 8, 12, 13, 22, 23, 32, 34–37, 40, 42, 43, 47, 57, 106, 113, 163, 172, 204, 208, 211, 217, 223, 226, 229, 241, 244, 247–249, 252, 276, 282, 295, 296, 300, 304, 305, 307, 324, 327, 328, 333, 338, 353, 354, 358, 360, 362, 366, 374, 375, 391, 392, 405–407  
 Public benefit, 304  
 Public engagement, 304  
 Public good, 304  
 Public opinion polling, 324  
 Puls Ltd., 327  
 Purpose, ix, 35, 41, 52, 74, 89, 96, 105, 125, 178, 197, 210, 218, 227, 241, 266, 278, 280, 298, 302, 329, 337, 383, 394, 400  
**Q**  
 Qualification, 4, 9, 137, 138, 181, 226, 263, 265, 267  
 Qualified, 43, 68, 149, 151, 159, 160, 163, 208, 230, 233, 240, 241, 256, 258, 260, 263, 265, 267, 270, 278  
     equally, 208, 263  
 Qualitative, 218, 365, 400  
 Quality, 10, 13, 31, 34–36, 40, 41, 43, 44, 51, 54, 57, 60, 67, 93, 95, 119, 123, 136, 138, 139, 172, 173, 177, 204, 206, 208, 214, 217, 218, 222–224, 229, 243, 257, 279, 280, 323–326, 332–334, 337, 351, 363, 375, 380  
 Quality control, 57, 280, 324  
 Quality of life, 323, 334, 363  
 Queer, 279  
 Quest, 296, 309–317  
 Question, ix, 33, 40, 77, 79, 111, 117–119, 122, 123, 147, 180, 189, 223, 227, 242,

- 265, 276, 279, 282, 287, 293, 294, 299,  
302–304, 311, 353, 357–360, 383, 400  
probing, 390
- R**
- Race, 7, 16, 17, 21, 24, 51, 132, 145, 154, 162,  
163, 172, 179, 192, 194, 212, 222, 225,  
226, 229, 235, 236, 243, 255, 260, 262,  
263, 265, 278, 279, 281, 285, 346, 347,  
351  
ethnicity, 21, 51, 132, 194, 278, 279, 285,  
351
- Racism, 158
- Ranks, 24, 109, 194, 203, 205, 207–210, 232  
faculty, 109, 191, 192, 194, 204, 232
- Rational basis test, 223
- Rationalize, 314
- Realism, 346
- Realistic, 23, 55, 121, 125, 139, 168, 245, 341,  
399
- Receptivity, 312, 317
- Recognition, 49, 52, 55, 57, 59, 60, 144, 150,  
174, 176, 199, 234, 243, 244, 246, 250,  
305, 366, 392
- Recognize, 13, 41, 53, 54, 58, 70, 73, 75–77,  
79, 96, 99, 100, 112, 133, 144, 161,  
168, 171, 192, 209, 218, 242, 251, 310,  
314, 323, 337, 367
- Recruiting, 55, 125, 131, 132, 135, 144, 148,  
165–167, 172, 177, 178, 201, 208, 213,  
214, 313, 350, 356, 357  
diversity segmented, 177
- Recruitment, 7, 9, 18, 135, 149, 150, 155, 156,  
172, 201, 214, 217, 218, 277, 280, 282,  
283, 354, 357, 364, 365
- Refine, 288, 304, 305, 307
- Reflect, 17, 21, 27, 117, 138, 179, 180, 206,  
249, 298, 302, 315, 361, 390, 405
- Reflecting, 55, 158, 204, 231, 300, 330, 395,  
407
- Reflection, x, 99, 206, 252, 317, 401  
personal, 317  
self, x, 97
- Re-focus, 250, 315
- Re-focusing, 250
- Regressing, 262
- Regression, 192–194, 231, 236, 258, 259,  
261–264, 267, 269, 285, 377, 393, 400
- Peters-Belson, 259, 261, 267, 269
- Regulations, 39, 155, 156, 173, 232, 257
- Rehabilitation, 141, 162, 240, 241
- Rehabilitation Act, 162, 240
- Relatable, 299, 317
- Relate, 108, 180, 300, 306, 323, 346
- Relation, 96, 97
- Relational, 311
- Relationships, 3, 20, 37, 67, 69, 79, 90–95,  
97, 108–110, 113, 120–123, 139, 141,  
144, 147, 149, 167, 178, 180, 198, 199,  
214–217, 240, 295, 299, 304, 310, 311,  
332, 334, 380
- Relevance, 256, 277, 377
- Relevant, 31, 34, 49, 66, 72, 80, 91, 94, 147,  
158, 161, 166, 178, 223, 224, 226, 228,  
244, 252, 256, 258, 260, 266, 269, 277,  
297, 299, 306, 312, 321, 336, 341, 389,  
391, 394, 404
- Reliability, 118, 122, 123, 270, 379
- Religion, 8, 16, 132, 158, 162, 163, 172, 175,  
212, 359
- Remedy(ies), 192, 193, 225, 227, 233
- Remedied, 236
- Report, Academic Salaries, 284
- Report, Department Profile, 277, 284
- Report, Employment Experiences, 283
- Reporters, 278, 295, 304
- Reporting, 22, 38, 48, 54, 89, 166, 285, 287,  
293, 375
- Report, New Doctorates, 277, 282, 283
- Report, Recruitment-Hiring-Attrition, 277, 283
- Representation, 21, 94, 133, 134, 149, 151,  
159, 177, 203, 212, 226, 277, 407
- Resolutions, 16–18, 83, 98–100, 113, 122, 123,  
145, 191, 208, 310
- Resources, 6, 9, 37, 39, 40, 53, 54, 57, 68, 108,  
112, 114, 132, 135, 141, 142, 145, 161,  
165, 172, 175, 188, 193, 196, 199, 217,  
218, 246, 247, 251, 268, 275, 286, 287,  
289, 304, 313, 349, 351, 353, 356, 359,  
366, 367, 371, 372, 403  
financial, 124, 246  
online, 68, 161
- Respect, 52, 81, 95, 122, 132, 134, 139, 146,  
147, 156, 174, 222–225, 232, 241, 252,  
263, 330, 337, 342, 355, 388, 391, 392,  
398, 404, 407
- Respected, 12, 122, 187, 188, 279, 312, 321
- Responsibility, 12, 24, 37, 40, 53, 58, 60, 81,  
133, 138, 139, 142, 144, 145, 150, 156,  
160, 161, 166, 167, 173, 181, 187, 257,  
258, 289, 301, 314–316, 321, 335, 347,  
376, 394, 404  
social, 150, 173, 181
- Retain, 13, 52, 133, 135, 163, 173, 209, 350,  
357, 368
- Retaliation, 268, 269
- Retaliation case, 268

- Retention, 7, 8, 12, 18, 48, 148, 149, 169, 172, 194, 201, 208, 354, 367
- Retiree, 229, 232
- Retirement, 197, 225, 228, 229, 233  
mandatory, 225
- Reward, 113, 120, 124, 144, 151, 163, 168, 304, 337, 365, 366
- Rewarded, 36, 41, 144, 233, 405
- Reward systems, 120, 124, 144
- Rights, 20, 24, 35, 82, 122, 148, 162, 170, 172, 222–224, 228–231, 234–236, 239–241, 251, 256, 259–262
- Risk(s), *x*, 20, 35, 36, 38–40, 42, 49, 75, 135, 138, 154, 166, 229, 232, 299, 305, 329, 373, 377, 381, 382, 397, 400, 401
- Roadmap, 33, 38–43, 312
- Role model, 17, 99, 149, 335
- Role play, 390
- Roles, 10, 39, 40, 43, 48, 53, 56, 60, 75–77, 81, 99, 124, 133, 138, 140–142, 144, 151, 172, 175, 177, 178, 201, 211, 233, 240, 246, 275, 288, 313, 321, 346, 347, 349, 362–364, 371, 383, 393, 397, 400, 403, 404, 407
- Rotations, 352
- Roundtable, 195, 394
- Row v Wade, 223
- Royal Statistical Society (RSS), 17, 295, 298, 325, 392, 393, 395
- Ruth Bader Ginsburg, 222
- S**
- Safe, 13, 18, 54, 58, 109, 112, 148, 355, 359, 360, 368, 402
- Safely, 111, 225, 294, 402
- Safe spaces, 13, 18, 360, 368
- Salary, 9, 140, 147, 191–195, 199, 203–210, 225, 229–233, 257–262, 264, 269, 276, 277, 280–282, 284, 286, 345, 377
- Salary equity, 191–195, 199, 204, 208
- Salary premium, 282
- Sampling Program for Foreign Statisticians, 331
- Samuel Wilks Memorial Award, 331
- Science, technology, engineering, and mathematics (STEM), 135, 173, 177, 178, 208, 275, 279, 281, 286, 289, 332, 376, 381, 396
- Science, technology, engineering, mathematics, medicine (STEMM), ix, 18
- Scott, E.L., 3, 9, 16, 192, 231, 331, 332, 356, 377, 380, 382, 396
- Screening, 49, 56, 165, 179–180
- Searches, 9
- Section 240, 242, 504
- Sections, ix, 7, 57, 65–67, 70, 75–80, 84, 121, 124, 140, 156, 159, 160, 162, 163, 176, 179, 188, 191, 196, 199, 211, 240, 242, 251, 256, 267, 268, 277, 283, 285, 310, 321, 325, 336–338, 372, 381, 383, 389–391, 394, 399, 401, 402, 404–407
- Self-assessment, 170, 380
- Self-awareness, 58, 83, 90, 95, 107–108, 175
- Self-confidence, 108, 331
- Self-examination, 310
- Self-identify, 243, 382
- Self-management, 37, 108, 109, 112
- Self-monitoring, 169
- Self-regulation, 90, 99
- Seniority, 141, 204, 257–259, 269
- Seniority system, 257, 258
- Sense About Science USA, 304
- Sensibilities, 251
- Sensitive, 13, 34, 35, 40, 41, 51, 70, 79, 94, 248, 311
- Sensitivity, 35, 94, 150
- Sex, 16, 17, 24, 162, 163, 179, 222–225, 229, 233, 235, 255, 257, 258, 264, 269
- Sexual assault, 16, 22
- Sexual harassment, 9, 15, 16, 22, 224
- Sexual orientation, 8, 16, 94, 132, 162, 212
- Sexual violence, 20
- Shape, 133, 200, 298, 310, 366, 378
- Shaped, 279, 301, 396
- Share, 12, 19, 23, 40, 47–60, 66, 67, 70, 74, 84, 105, 110, 111, 132, 134–136, 143, 146–149, 151, 179, 180, 198, 208, 266, 279, 289, 298, 309, 311, 312, 315, 322, 323, 332, 337, 342, 349, 354, 361, 366, 368, 381
- Shared, 14, 39, 47, 56, 81, 82, 110–114, 143, 145–148, 150, 160, 165, 175, 223, 302, 311, 314–316, 330, 337, 342, 361, 394  
meaning, 112  
reality, 112  
vision, 47, 114
- Sharing, 35, 41, 50, 52–54, 57, 93, 115, 149, 174, 194, 296, 310, 313, 334, 335, 351, 359, 361, 379, 388, 403
- Shortfall method, 267
- Significant, 12, 34, 53, 91, 142, 144, 149, 175, 177, 181, 196, 199, 205, 206, 208, 209, 223, 232, 241, 257, 259, 261–264, 268–270, 293, 311, 312, 315, 316, 323, 325, 328, 397, 400  
statistically, 206, 209, 232, 258, 261, 263, 269

- Similarities, 120, 136, 213, 294, 337
- Similarly situated, 229, 230, 257, 258, 265, 266
- Skills, 31, 47, 67, 90, 105, 137, 154, 165, 171, 200, 212, 221, 243, 257, 305, 323, 351, 372, 392
- soft, 401
- storytelling, 305
- Skill sets, 47, 49, 52, 137, 139, 147, 351, 359, 368
- Social, 3, 20, 33, 84, 89, 105, 119, 132, 167, 173, 188, 203, 213, 222, 243, 276, 300, 324, 341, 352, 374, 397
- awareness, 107–109
- class, 132
- cognition, 121
- identity, 11
- inequality, 11
- intelligence, 89–91
- justice, 189, 377
- skills, 90, 91, 99, 107–109, 329
- Societies
- professional, 66, 240, 373, 383, 404, 405
- statistical, 4, 16, 17, 192, 270, 295, 325, 335–338, 363, 387, 392, 393, 404, 406
- Society for Advancement of Chicanos, 178, 215
- Society for Industrial and Applied Mathematics (SIAM), 281, 290
- Sonya Kovalevsky Workshops, 234
- Special, 13, 16, 79, 89, 139–141, 156–158, 180, 192, 197, 212, 241, 246, 249, 285, 303, 324–325, 336, 345, 356, 357, 376
- Special treatment, 249
- Speculate, 373, 376
- Speculation, 373
- Speech, 250, 392, 393
- difficulties, 250
- recognition technology, 250
- StatFest, 178, 198–200, 353, 362, 366, 367
- Statistical Bureau of the Republic of Serbia, 331
- Stats and Stories, 300, 301, 303
- STATS initiative, 295, 304
- Status quo, 14, 24, 173, 357, 368
- Statutory criteria, 260
- STEM Inclusion Study, 279, 286, 289
- Stereotype, 33, 179, 226
- Stereotyping, 15
- Stimulation, 122, 338
- Stimuli, 297
- Story(ies), 8, 146, 147, 198, 228, 281, 293–307, 309–313, 315–317, 332, 333, 343, 366, 389
- compelling, 295, 303, 304
- structure, 297
- Storytellers, 295, 299, 301, 303, 304
- data, 295
- Storytelling, ix, 228, 296–306, 309–311, 317, 382, 383
- academic, 302
- Strata, 268
- Strategy(ies), 16, 18, 26, 35, 37, 47, 48, 54, 60, 70, 96, 98, 107, 112, 113, 148, 155, 156, 158, 159, 171–173, 176–178, 181, 197, 211, 215, 243, 285, 296, 403
- Strategic, 16, 18, 35–41, 60, 70, 72, 73, 91, 100, 133, 135, 144, 154, 155, 159, 161, 172, 212
- leadership, 37
- thinking, 144
- Strategic planning, 60, 91
- Strategic plans, 16, 39, 154, 155, 159, 161
- Stratified, 263, 265, 268, 285
- Student organization, 213, 218
- Styles, ix, 13, 60, 65, 70–73, 75–79, 83, 96–99, 122–126, 133, 136, 151, 218, 288, 296, 306, 344, 351, 363, 388
- learning, 351
- Subconscious, 15
- Subculture, 15
- Subgroups, 21, 23, 27, 56, 168, 174, 177, 263, 265, 270
- Successes, 11, 13, 15, 16, 18, 23–25, 36–38, 41, 43, 48, 49, 52, 54, 56, 58, 70, 73, 74, 76, 77, 79, 89, 97, 109, 110, 113, 131, 136–140, 146–151, 168, 169, 172, 196, 197, 201, 208, 214, 217, 218, 224, 232, 235, 243, 255, 256, 263, 265, 310, 313, 315, 317, 322, 323, 328, 329, 337, 344, 351, 357, 390, 397–399
- rate, 255, 256, 263
- Successful, 13, 16, 24, 25, 35–44, 48, 49, 53, 54, 58–60, 68, 70, 77, 90, 93, 114, 137–139, 142, 158, 166, 172, 178, 196, 199, 215, 225, 227, 231, 232, 243, 255, 256, 263, 278, 281, 302, 313, 330, 332, 351, 358, 363, 401, 402
- Succession plan, 280–282, 289
- Summary judgment, 256, 265, 268–270
- Summer Institute in BioStatistics (SIBS), 213
- Summer Institute in Social Research
- Techniques, 324
- Summer program, 25, 213–215, 217, 351, 352, 356, 358, 361
- Supervising, 80, 136, 169, 246
- Supervision, 49, 71, 169, 350

- Supervisors, 21, 23, 55, 59, 91, 95, 96, 159, 161, 163, 169, 248, 251, 266, 290, 350, 356, 357, 367–368
- Supply and demand, 280
- Supreme Court, 223, 225, 227, 230, 232, 261, 262, 269
- Surveys, 34, 35, 55, 56, 132, 134, 150, 151, 154, 174, 175, 188, 189, 240, 275–290, 299, 324, 325, 330–332, 400, 404  
     sampling, 281, 324, 331  
     statisticians, 325, 331  
     statistics, 325, 331
- Synergies, 71, 171, 173
- Synergistic, 37
- Synthesis, 297, 401
- Synthesize, 37
- Synthesizing, 407
- Systems, ix, 13–16, 21, 23, 32, 50, 57, 81, 82, 92, 93, 113, 120, 124, 144, 155, 162, 163, 181, 189, 223, 228, 233, 235, 257, 258, 261, 280, 289, 296, 299, 310, 312, 313, 315  
     change, 315
- T**
- Talent, 133–136, 150, 151, 169, 171–181, 243, 280, 313, 316, 391
- Talent acquisition, 171–181
- Talented, 12, 81, 166, 168, 214, 314, 345, 350
- Talent market, 133
- Target, 38, 142, 177, 178
- Targeted, 7, 13, 17, 38, 74–76, 132, 135, 178, 181, 195, 199, 215, 216, 312, 323, 330
- Teaching Effectiveness Colloquia (TEC), 66, 67, 69, 77, 79, 80
- Team, 6, 23, 39, 47, 65, 96, 106, 120, 135, 158, 166, 171, 190, 247, 293, 312, 323, 345, 349, 379, 392  
     crossfunctional, 171  
     high performance, 296  
     multidisciplinary, 8, 35, 48, 51, 53, 60, 390, 398, 404
- Team brain, 346
- Team science, 47–60, 114, 361, 362
- Teamwork, 391
- Technical, 14, 32, 38, 41, 68, 77, 78, 120, 137, 148, 159, 165, 174, 209–210, 217, 239, 244, 246, 285, 299, 300, 305, 326, 330, 347, 351, 371, 373, 382–383
- Technical audience, 305, 382–383
- Technical work, 165, 305
- Technocracy, 305
- Technological change, 31–33
- Technology, ix, 31–33, 40, 42, 44, 67, 117, 125, 140, 177, 181, 242, 250, 279, 281, 332, 392, 393, 406
- Telling, ix, 110, 280, 296, 299, 301, 303, 306, 311, 315, 334, 357, 382, 395
- Tenure, 5, 10, 55, 114, 194, 201, 204–209, 233, 262, 264, 277, 283, 285, 310, 359–361, 366, 373, 374
- Tenured faculty, 206, 235, 276, 278
- Termination, 260
- Thermostat, 322, 323
- Thermometer, 322, 323
- Thermostat, 322, 323
- Thermostat mode, 323
- Thesis, 106, 297, 332, 380
- The UN Refugee Agency, 8, 234
- Thoughtful, ix, 4, 52, 132, 181, 253, 287, 289, 384
- Thoughtfulness, 124, 251
- TIAA-CREF, 229, 230, 233
- Time, 4, 20, 31, 48, 68, 98, 105, 115, 136, 158, 166, 174, 187, 203, 212, 223, 239, 255, 276, 294, 309, 323, 341, 351, 372, 391
- Timeline, 51–54, 58, 168
- Title, 35, 51, 162, 163, 224, 225, 229, 230, 256, 257, 259–262, 266–268, 302, 378
- Title II, 224
- Title IV, 224
- Title IX, 224
- Title VI, 224
- Title VII, 162, 224, 225, 229, 230, 256, 259–261, 266–268
- Tolerance, 93–95, 100  
     zero, 100
- Tolerant, 95
- Toolkit, 135
- Track, 4, 32, 56, 59, 113, 140, 142, 194, 208, 209, 275–278, 283, 288, 301, 345, 360–362
- Tragedy, 299
- Training, 6, 8, 9, 25, 41, 42, 48, 49, 53, 54, 56, 58–60, 90, 91, 95, 106, 109, 123, 145, 147, 149, 151, 160, 161, 172, 176, 187, 200, 201, 212–214, 226, 234, 247, 270, 277–278, 280–282, 285, 287, 294, 301, 305, 324, 331, 362, 365, 366, 390, 402, 403, 405
- Training programs, 41, 60, 95, 247, 362, 365
- Traits, 58, 79, 95, 99, 121, 138, 179, 347, 387, 391, 407
- Transactional, 110, 329
- Transactional conversation, 110
- Transfer of understanding, 298

- Transformation, 23–24, 309, 310, 313–317, 366
- Transformational, 72, 97, 122, 123, 125, 126, 312, 329, 338
- conversation, 110
- leader, 72, 94, 121–123
- Transformative, 23
- Transgender, 188, 189, 233, 279
- Transition, 37, 166, 197, 328, 358, 361
- Transitioning, 358
- Translate, 12, 177, 243, 296, 306
- Translation, 56, 399
- Translator, 306, 343, 344, 390
- Transparency, 37, 149, 156, 206, 333, 404
- Transparent, 40, 51, 58, 150, 174, 391, 404
- Treatment, 21, 33, 48, 68, 120, 167, 169, 175, 221, 226–228, 230, 246, 249, 259–261, 264, 265, 268–270, 365
- favorable, 260, 264
- Trend, 34, 48, 131, 143, 151, 177, 206–208, 283, 289
- Trial, 147, 224, 226, 227, 234, 255, 262, 267, 268, 270, 363–365
- pre-, 255
- True, 8, 40, 79, 81, 119, 166, 196, 218, 236, 260, 264, 287, 288, 296, 301, 303, 313, 331, 337, 389
- Trust, 12, 34, 52, 58, 59, 83, 84, 94, 96, 109–113, 133, 139, 174, 175, 215, 297, 310, 313, 329–331, 337, 373, 395
- Trust building, 111
- Trusting, 37, 134, 393
- Trustworthy, 37, 81
- Truth, 82, 83, 234, 379
- Truth-telling, 37
- U**
- Under-represented, 112, 206, 212, 213, 332
- Under-represented minority (URM), 195, 206, 213, 215, 217
- UNESCO, 394
- Unfair, 23, 120, 175, 225, 270, 300
- Unfairness, 261–263, 268
- Unhealthy, 107, 179
- UNICEF, 327
- Unintentional., intentional, 21, 23, 24, 26, 27, 322, 406
- Unique, ix, 11, 12, 27, 53, 54, 56, 59, 65, 72, 76–79, 126, 145, 154, 169, 177, 200, 249, 281, 285, 296, 306, 312, 337, 351
- Uniqueness, 329, 336, 337, 358
- United Nations Convention to Eliminate Discrimination against Women (CEDAW), 224
- United Nations High Commission for Refugees (UNHCR), 327
- United States Supreme Court, 222
- Universal design, 244
- Unselfish, 337, 388, 407
- Unselfishness, 337, 405
- Urban Conference, City College, NY, 215
- U.S. Census, 34, 281, 282, 286
- V**
- Valuable, 12, 36, 39, 67, 100, 131, 135, 146, 180, 213, 336, 383, 387, 392
- Value, 8, 11, 36, 40, 41, 44, 51, 58, 63, 68, 91, 100, 133–136, 138–140, 142, 144, 168, 171–174, 178, 181, 192, 203, 212, 243, 244, 251, 261, 267, 287, 288, 302, 305, 310, 315, 329, 358, 361, 391, 396, 402, 403
- Valued, 42, 94, 124, 132, 135, 147, 154, 173, 175, 251, 358, 362, 364, 367, 405
- Vent, 188, 358
- Versatility, 344
- Vertical Integration of Research and Education in the Mathematical Sciences (VIGRE), 214
- Veterans, 38, 155, 156, 176, 178, 241
- Visibility, 24, 27, 57, 60, 137, 141, 142, 168, 200, 217, 250, 332, 388, 393, 405
- Visible, 14, 39, 54, 132, 188, 215, 249, 250, 343
- Vision, x, 3–18, 38, 47, 49, 50, 53, 79, 114, 115, 122, 133, 155, 215, 240, 301, 312, 313, 316, 317, 332, 333, 335, 337, 396, 405
- Visionary, 72, 376, 394
- Voice, ix, 24, 32, 110, 180, 250, 317, 322, 405
- public, 405
- Volunteer, 79, 135, 159, 160, 166, 277, 381, 383
- Volunteer experiences, 159
- Volunteerism, 65, 74–79
- W**
- Wages, 231, 257, 258
- differential, 258
- systems, 257
- Web Accessibility Initiative of the World Wide Web Consortium (W3C), 246
- Wheelchair, 10, 241, 242, 250, 252, 310, 311

- White, 9, 23, 24, 32, 39, 192–196, 198, 227, 233–235, 245, 246, 257, 258, 260, 262, 314, 342
- Wiley Encyclopedia of Operations Research and Management Science (EORMS), 67–69, 75–77, 79
- Wisdom, 80, 90, 258, 268, 288, 331, 373  
practical, 90
- Women, 3, 22, 90, 118, 131, 153, 166, 174, 190, 203, 221, 255, 279, 314, 321, 347, 349, 371, 398
- Women in Statistics, 9, 131, 147–149, 178, 200, 235, 284, 324–326, 336, 337, 371, 377
- Women in Statistics and Data Science (WSDS) Conference, 24, 149, 178
- Women in STEM Award, 332
- Work-life, 134, 150
- Workloads, 54, 56, 139, 403
- Workplaces, ix, 4, 5, 11–13, 35, 43, 94–96, 131–135, 139, 145, 147, 150, 156, 159, 160, 162, 163, 174, 175, 243, 245, 246, 248, 249, 251, 279, 314, 322, 324, 333–335, 387, 388, 391, 397–399, 401, 403–405
- Works, 5, 22, 33, 50, 70, 91, 106, 117, 131, 154, 166, 174, 191, 203, 212, 221, 242, 257, 275, 294, 309, 322, 344, 347, 372, 388  
ethic, 143, 354, 358  
hard, 14, 159, 235, 306, 328, 329, 350, 351, 360, 377
- World Bank, 132
- World Health Organization (WHO), 327
- World Statistics Congress (WSC), 334, 375, 392
- Writing, x, 6, 32, 49, 50, 57, 67, 109, 111, 137, 167, 169, 276, 285, 296, 301, 303, 304, 345, 358, 360, 373, 376, 378, 380, 381, 395, 405  
science, 301, 304
- X**
- XY Story Formula, 303