Difficult Dialogues in the Midwest: A Retrospective on the Impact of EDGE at Purdue University

Alejandra Alvarado, Donatella Danielli, Rachel Davis, Zenephia Evans, and Edray Herber Goins

Abstract EDGE 2016 was held at Purdue University from June 6 through July 2, 2016. This meeting brought together some 20 participants from the EDGE program along with alumni from the Midwest EDGE Cluster at Purdue, graduate students from the Purdue Chapter of AWM, and undergraduate students from the local REU titled PRiME (Purdue Research in Mathematics Experience). In this article, we discuss the impact of EDGE 2016 on Purdue University, as told by the Midwest EDGE Cluster and AWM advisor Donatella Danielli; Mini-Course leader Rachel Davis; Difficult Dialogue leader Zenephia Evans; and local organizers Alejandra Alvarado and Edray Goins.

A. Alvarado
Eastern Illinois University, Department of Mathematics and Computer Science, Charleston, IL, USA
e-mail: aalvarado2@eiu.edu

D. Danielli
Purdue University, Department of Mathematics, West Lafayette, IN, USA
e-mail: danielli@math.purdue.edu

R. Davis
University of Wisconsin at Madison, Department of Mathematics, Madison, WI, USA
e-mail: rachel.davis@wisc.edu

Z. Evans
Purdue University, Office of the Dean of Students, West Lafayette, IN, USA
e-mail: zevans@purdue.edu

E. H. Goins (✉)
Pomona College, Department of Mathematics, Claremont, CA, USA
e-mail: edray.goins@pomona.edu; ehgoins@mac.com

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1 Introduction

It was a sunny July afternoon in West Lafayette, Indiana. Edray Goins was escorting Ulrica Wilson around Purdue University, showing her the campus before she addressed the Department of Mathematics with the talk entitled *Division: In an Algebra, In a Career, and In Research Mathematics*. She had just finished a lunchtime meeting with a handful of tenure-track faculty of color who were from the College of Science.

Little did Ulrica know that Edray had ulterior motives for inviting her to visit Purdue. He wanted to convince her that the EDGE Program should be held at the West Lafayette campus one day. She had just finished teaching at EDGE 2011 as the Algebra Instructor, and she would take over from Sylvia Bozeman and Rhonda Hughes as one of the two EDGE co-directors beginning with EDGE 2012 at Pomona College. Since the inception of the EDGE in 1998, the program had been hosted at a variety of locations, but never at a tier one university in the Midwest. Purdue University had a lot to offer EDGE, but Edray wanted to bring the program to West Lafayette for what EDGE would offer to Purdue. The mission of EDGE is in its name: Enhancing Diversity in Graduate Education. The EDGE Program has always assembled together a diverse group of women for 4 weeks in the summer, and Edray's goal was to combine this activity with other communities at Purdue striving to address issues involving inclusion and access.

It would take five more years before EDGE would come to Indiana. After extensive work and preparation, EDGE 2016 was held at Purdue University from June 6 through July 2, 2016. This article contains reflections from five individuals who ran EDGE 2016 (titles during summer 2016 in parentheses):

- Edray Goins, local organizer (Associate Professor of Mathematics at Purdue)
- Alejandra Alvarado, local organizer (Assistant Professor of Mathematics at Eastern Illinois University)
- Donatella Danielli, leader of the Indiana EDGE Mentoring cluster (Professor of Mathematics at Purdue)
- Rachel Davis, leader of a mini-course at EDGE on using the Sage cloud (now CoCalc) for computations. (Golomb Visiting Assistant Professor at Purdue)
- Zenephia Evans, leader of "Difficult Dialogues," two 2-h workshops to help prepare the participants for their first year of graduate school (Director of the Science Diversity Office at Purdue).

2 Reflections from Edray Goins and Alejandra Alvarado, Local Organizers

Structure of the Program As local organizers, we were responsible for coordinating four faculty (Maia Averett, Raegan Higgins, Eirini Poimenidou, and Shelby Wilson), one instructor (Rachel Davis, who lead a course entitled "SAGE: System

Fig. 1 EDGE 2016 group photo from June 8, 2016

for Algebra and Geometry Experimentation"), one "Difficult Dialogues" facilitator (Zenephia Evans), three mentors (Chassidy Bozeman, Angelica Gonzalez, and Stefanie Wang), and 14 students (Alicia Arrua, Sarah Chehade, Zaynab Diallo, Genesis Islas, Meghan Malachi, Zonia Menendez, Kirsten Morris, Erica Musgrave, Nida Kazi Obatake, McCleary Philbin, Amanda Reeder, Stephanie Reyes, Morgan Strzegowski, and Sarah Yoseph).

The students would take classes for the first 2 weeks (Linear Algebra and Analysis), have a short break for the "Reunion Weekend," then resume with classes for the final 2 weeks (Abstract Algebra and Measure Theory). The mentors and students worked, lived, and ate together on campus. There were also eight invited speakers (Christine Berkesch, Sarah Bryant, Deidra Coleman, Donatella Danielli, Piper Harron, April Harry, Erin Militzer, and Carmen Wright). We made a conscious effort to have the 20 or so EDGE 2016 participants interact with the Purdue Chapter of AWM as well as the REU PRiME (Purdue Research in Mathematics Experience). Students from these three groups had lunch together and attended the seminars together, with the hope that they would connect through the shared experience of being in an immersive mathematics environment. We are thankful to the supportive faculty and staff who worked with us to ensure that the participants had a challenging and fulfilling experience (Fig. 1).

The Impact on Purdue We were well aware that EDGE was unlike anything that the Department of Mathematics had seen before. Purdue has only graduated one African American woman in mathematics (Kathy Lewis in 1999), and has never graduated a US Latina in mathematics. The department has some 60 tenure-track and tenured faculty, yet only five are women. The department hosts some 30 colloquium speakers every year, yet we are lucky if three are women. Professor Rodrigo Bañuelos remarked to us after Piper Harron gave her talk during the program: "That was a remarkable speech. She spoke about the perils of being a

graduate student, doing mathematics, and being pregnant at the same time. I imagine this is the first time anyone has ever spoken about being pregnant in this colloquium room." We suspect Rodrigo is completely correct.

We are not aware of whether the number of applications from domestic students, women, or underrepresented minorities has increased at Purdue since 2016–2017. However, we believe having EDGE at Purdue for those 4 weeks showed the mathematics faculty what a diverse department could look like. Mathematics graduate student Joan Ponce (one of Edray's mentees) put it this way: "I think the EDGE program is an amazing opportunity. I just wish it was longer."

3 Reflections from Donatella Danielli, Mentoring Leader

EDGE's Mentoring Clusters Mentoring is a crucial component of the EDGE experience. EDGE students are mentored by the EDGE summer faculty, the advanced graduate student assisting with the program, and the directors. As an expansion of one-on-one mentoring, in 2005 EDGE created regional Mentoring Clusters for women in the mathematical sciences, with financial support originally provided by an NSF ADVANCE grant. The goal of this structure is to advance women in academia at the three fundamental levels of graduate school, junior faculty and senior faculty, by creating mentoring networks among small groups of women in relatively close geographical proximity. The guiding principle is that, through periodic gatherings and frequent communication, the Clusters would facilitate the mentoring of junior women by senior women and the mentoring of graduate students by those in the other two groups. Hence, such a network would assist the younger two groups in advancing their professional goals while relying on the expertise of senior faculty. Although many of the students and junior faculty in the Clusters have been past participants in EDGE, other women mathematicians, at different stages of their career, have also joined in.

Currently there are seven regional EDGE Clusters: California, Georgia, Indiana, Iowa, Mid-Atlantic, Minnesota, and North Carolina. In addition, there is a non-regional Cluster focusing on Mathematics Education. Since its inception, I have had the pleasure of being the Leader of the Indiana Cluster, whose members have been affiliated with Indiana University, Notre Dame University, Purdue University, and the University of Illinois at Chicago. At any given time, the Cluster has had seven to ten active members, and we have strived to meet at least once a year. For some of the members this is a considerable effort, given that the various institutions are not in very close proximity to each other. However, I find remarkable how everybody is always enthusiastic to carve the time out of their own busy schedule to convene with their fellow EDGErs, to keep in touch and exchange ideas.

The Cluster gatherings and relationships have provided the graduate students with a forum to discuss issues on many academic and non-academic topics that impact their progress. Through the Cluster, junior faculty have raised issues related to finding early professional opportunities and negotiating the responsibilities of

Fig. 2 Donatella Danielli and Alejandra Alvarado on June 7, 2016

the early stages of their careers. Even if the Cluster members have very different backgrounds, some topics discussed in our conversations seem to be of recurring interest, such as:

- General assessment of how female graduate students and junior faculty feel treated in their respective departments;
- Balancing family and career;
- Comparison of teaching loads and course requirements in different departments;
- Entering graduate school a few years after college graduation;
- Transferring from one graduate program to another;
- How to choose an advisor.

Moreover, all the graduate students have expressed repeatedly their appreciation for the EDGE program, which helped to make their transition to graduate school much easier (Fig. 2).

Purdue's Mentoring Cluster In recent years, some of the Cluster meetings have been held in conjunction with the Women in Math Day at Purdue University, which is an annual initiative of the Department of Mathematics at Purdue. The spirit of this event is to provide an opportunity for women members of the department (faculty and students alike) to interact with each other and with a prominent female mathematician, who delivers the scientific highlight of the day, the Jean E. Rubin Memorial Lecture. Other activities of the day typically include a luncheon for all women members of the department, as well as female faculty members and graduate students from other disciplines at Purdue. The luncheon is followed by an informal meeting during which students and faculty can interact with each other and with the distinguished guest. The synergy between the two events has been beneficial

for the Cluster members in several respects. In fact, it has allowed them to discuss their concerns with distinguished members of the mathematical community in a very relaxed and informal setting; it has expanded their professional network; it has inspired them to create similar events in their own institution. The Indiana Mentoring Cluster is an important support system and networking opportunity for its members. It is our hope and goal that it would constitute a crucial component in improving the status of women mathematicians in academia.

4 Reflections from Rachel Davis, Short Course Instructor

Sage and EDGE I knew Alejandra because we both had Edray Goins as a mentor during our time as postdocs at Purdue. During the Midwest Women in Mathematics Symposia, modeled after successful WIMS held in Southern California, Alejandra shared her idea that the EDGE 2016 mini-course topic could be mathematical computations in Sage. I was eager to join the team and introduce the students to Sage.

Sage stands for "System for Algebra and Geometry Experimentation" [5]. It is a computer algebra system founded by William Stein, a mathematician affiliated with the University of Washington. Computation itself has a history at Purdue–the first Department of Computer Sciences in the USA was established at Purdue University in 1962 (Fig. 3).

Sage covers mathematical computations from subjects ranging from calculus and statistics to algebra, combinatorics, graph theory, numerical analysis, and number theory. Sage is open-source, i.e., the computer code underlying the computational functions is shared openly, so that users have the ability to view and to improve

Fig. 3 Rachel Davis on June 8, 2016

the design of the software. There are also Sage Days conferences devoted to software development by interested mathematicians. (See [8] for more information and to get involved.) During the EDGE mini-course, participants signed into the SageMathCloud, which now goes by CoCalc (Collaborative Calculation in the Cloud). The hope was that Sage and EDGE would pair nicely with each other. In particular, Sage computations can help EDGE participants by providing intuition for mathematical research questions.

A Lasting Connection It is impressive to me that so many mathematicians involved in EDGE have returned to EDGE. As of 2016, Alejandra Alvarado has held *multiple* roles in EDGE as participant, mentor, speaker, instructor, and local organizer. In 2016, most of the mentors, instructors, and even guest speakers were former participants or closely related to the program. This involvement of mathematicians at different stages in EDGE is one way that EDGE has been able to excel at mentoring. Previous EDGE participants and advanced graduate students have gained practical experience facing the challenges of graduate school. In this way, EDGE has built an inspiring community of mathematicians and shines a spotlight on their accomplishments.

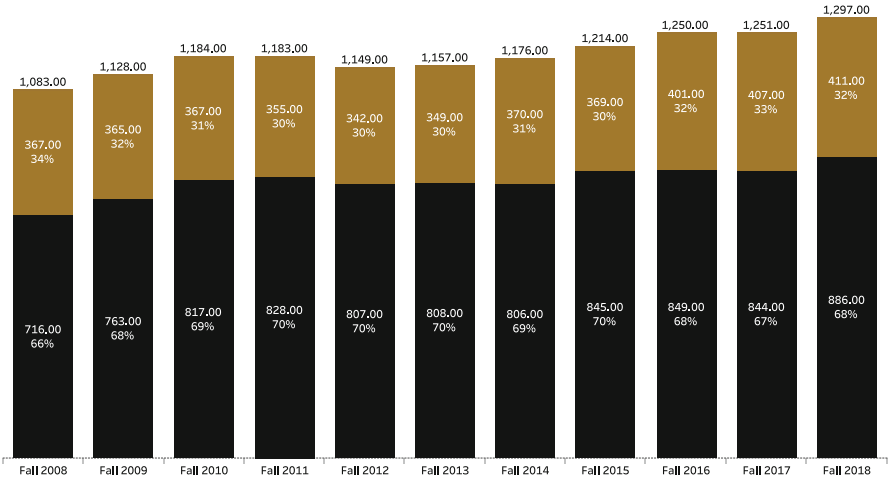
5 Reflections from Zenephia Evans, "Difficult Dialogues" Leader

Why Is EDGE Necessary? One of the featured news articles describing the panel session, *The Gender Gap In Mathematical and Natural Sciences from a Historical Perspective*, hosted during the International Congress of Mathematicians (ICM) meeting in August of 2018, discussed the lack of women in the mathematical realm [1]. The panelists noted that only one woman has earned the Fields Medal since it was established in 1936, and only 15% of the featured 200 speakers were female over the 9 day program. The lack of women is a frequent conversation topic at conferences, in mathematics departments, and many other places. EDGE remains necessary because the program aims to remove the barriers that may prohibit substantial increases of women in the mathematical arena.

Empowered and Informed by Data A version of the "Difficult Dialogues" workshop has been held at every EDGE summer session since 1999. During the EDGE session at Purdue University, I worked with the organizers to design 2-h sessions that would address the needs of women as they make the transition from undergraduate to graduate programs. We were greatly influenced by the book *Successful STEM Mentoring Initiatives for Underrepresented Students* [2]. We aimed to highlight the numbers of women who pursue mathematics; to explore the self-awareness of the participants; to stress the importance of creating a strong network of allies, advocates, and mentors; to share tips to deal with Imposter Syndrome; and to encourage participants to develop a plan that would aid in their success as graduate students.

The attendees learned of the historical numbers of newly minted PhDs, as recorded by various surveys conducted by the American Mathematical Society [6], and were encouraged to monitor the numbers during their career. We stressed this as important because the data can allow the women to have a supporting narrative to bring awareness to this issue on the national and local levels. We did not present the data of women enrolled in each of the graduate programs among participants, but we did showcase the Data Digest at Purdue University [7], and challenged the participants to seek and know the data that is available for their perspective graduate programs. The College of Science at Purdue University has enrolled approximately 31.4% of women in the graduate programs from 2008 to 2018. The total graduate enrollment in 2018 was 1297 students, where 411 (32%) were female—which is the highest number of women and the third highest percentage since 2008 (34%) during this time frame. See Fig. 4.

The numbers are important because the lack of critical mass in certain environments may hinder the positive development of self-awareness of females that are entering the field of mathematics and other science majors. One of the concepts that can lead to success is to be aware of the traits that one possesses and those which may pose a challenge to one's chosen academic path. Self-awareness will allow one to stand strong in the face of doubt and to provide a method to combat the negativity which may be encountered during graduate school. Researchers have



Filters: Color by: Gender, Measure by: Headcount, Semester: Fall, Campus: West Lafayette, College: College of Science, Department: Detail not Available, Major: Detail no available, Student Level: Graduate, Gender: All, Race/Ethnicity: All, Underrepresented Minority: All, Residency:All, Federal FT/PT Status: All, Age Range: All, Teacher Education: All

Female Male

	Fall 2008	Fall 2009	Fall 2010	Fall 2011	Fall 2012	Fall 2013	Fall 2014	Fall 2015	Fall 2016	Fall 2017	Fall 2018
Female	367.00	365.00	367.00	355.00	342.00	349.00	370.00	369.00	401.00	407.00	411.00
Male	716.00	763.00	817.00	828.00	807.00	808.00	806.00	845.00	849.00	844.00	886.00

Fig. 4 Enrolled graduate students by gender in the College of Science at Purdue University (https://www.purdue.edu/datadigest/)

sited that persistence in STEM and other areas can be hindered if the individual does not have a sense of belonging in the spaces that they occupy. In order to have the sense of belonging, a level of self-awareness is necessary [4]. This awareness is heightened by knowing the requirements and being able to meet the requirements in the department, by earning the grades, passing qualifiers/comprehensive exams, and so forth.

Allies, Advocates, and Mentors As facilitators working with new graduate students, we wanted to stress the importance of being connected to a strong network of allies, advocates, and mentors. This network can be formed by a variety of people, including classmates, staff, faculty, and administrators. We wanted the participants to be mindful of the importance of networks that are necessary to assist in the navigation of new and unfamiliar academic terrain at their perspective institutions. Allies often are discovered in both on formal and informal settings at the college/university, conferences, and through normal day activities in the community. The EDGE participants have sole ownership in observing and monitoring their self-awareness in order to build an ally group that can motivate, encourage, and challenge them as they satisfactorily meet their program requirements (Fig. 5).

We discussed the importance of identifying advocates and selecting mentors that will support your success as a graduate student. This will require the participants to have conversations with former and current graduate students and others that interact with the potential mentors. Being able to engage in open and direct conversations with mentors to ensure success as a graduate student is essential but not trivial or

Fig. 5 Sylvia Bozeman, Zenephia Evans, and Edray Goins at the reunion weekend on June 18, 2016

easy. In sessions, we modeled this skill for the EDGE participants. We provided questions to ask about a potential mentor and practiced difficult conversations with potential mentors about needed time off, direction of the research, and funding for graduate school. Intentional allies, positive advocacy, and great mentorship can serve as connections to increase and build the self-awareness of the participants, whereas negative allies, advocates, and mentors can decrease the view of self and lead to development or enhancement of Imposter Syndrome (see below).

Imposter Syndrome Imposter Syndrome was first described in 1978 by clinical psychologists Clance and Imes [2] as a pervasive feeling of self-doubt, insecurity, or fraudulence and can occur once a person has been admitted to a prestigious university, received an award or promotion. Imposter Syndrome can strike anyone at any level of life. We wanted to ensure that the EDGE participants could define and be aware of the syndrome, learn some tips to deal with it, and develop a personal plan that will aid in their success when and if Imposter Syndrome strikes during the course of their graduate studies.

We read and discussed a *Scientific American* article by Hendriksen [3]. In particular, we reviewed the tips that have been developed to address Imposter Syndrome: know that feeling like a fraud is normal; remind yourself of what you have accomplished; tell a fan; seek out a mentor; teach; know that sometimes it is okay not to know what you are doing; praising efforts of kids; build in an expectation of initial failure. By presenting this content, we wanted to showcase the possibilities and the means needed to combat the experience of Imposter Syndrome.

Who Gets To Tell Your Narrative? During the 4 h of dialogue, we discussed difficult topics which may interfere with the success of the EDGE participants as they progress in the graduate programs. In the session "Who Gets To Tell Your Narrative?" we initiated the discussion by having the participants list the traits they possess that are needed to be mathematical trailblazers. We then asked them to recall and describe a situation when someone said or did something to get them to question the traits listed, and we walked through the negative reinforcements of the given narrative and discussed the possible outcomes which could result in knocking away at their self-confidence. We ended this part of the session by sharing ways which they could regain the positive reinforcements to combat the negativity of the narrative. In order for successful persistence in a field that is male-dominated, it is necessary to consistently monitor self-awareness, work to knowingly build a strong network of allies, advocates, and mentors, and understand Imposter Syndrome.

6 Concluding Remarks from Edray and Alejandra

Organizing and coordinating all details of the EDGE 2016 summer session at Purdue required planning that began in earnest during the Fall of 2015. We thank the many supportive people at Purdue and in the EDGE program that made this possible, including: Gregery Buzzard, Department Head of Mathematics; Hao Zhang,

Department Chair of Statistics; Rodrigo Bañuelos and Johnny Brown, Professors of Mathematics; Mark Ward, Associate Professor of Statistics; David Goldberg, Professor of Mathematics and Executive Director of the National Alliance for Doctoral Studies in the Mathematical Sciences (The Math Alliance); Ethan Kingery, of Purdue Conference Services; and the EDGE directors Ami Radunskaya and Ulrica Wilson.

During the 2011–2013 academic years, we worked together to organize summer speaker series where we brought a diverse group of early career female faculty to talk to students and faculty. We are so grateful that Ulrica visited one of those bright summers and (with thanks to this team) made the vision of hosting EDGE at Purdue a reality.

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