CHAPTER 16

Critical Thinking and Scientific Integrity: Are University Students Ready Enough to Be Engaged?

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Introduction

Successfully engaging in a high-quality curriculum is a crucial factor in students' academic success. The curriculum should include developing research skills, core scientific competencies, and ethical research practices. These are skills necessary for students to become contributing members of the scientific community. However, when arriving at the university, young people face many challenges. They need to adjust to new academic strategies and a different pace of work. They also must adapt to new teaching methodologies and evaluation; and more autonomy in studying and learning. On a personal level, it is necessary to strengthen the student's identity as an adult, confirm their commitment to a vocational pathway, and develop autonomy (Almeida et al. 2000). New patterns of interpersonal

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relationships with family, peers, teachers, and other authority figures are additional areas requiring adaptation. It is not an easy developmental process.

University courses provide the framework for creative research activity. Still it is the interaction with faculty, peers, junior (undergraduate students), and senior researchers (masters and PhD students) that feed new students with active, inquiry-based learning experiences (Kinzie and Husic 2010). The university is a space that is considered a center of creation, transmission, and broadcasting of culture, science, and technology (Pacheco 2003). However, should we integrate undergraduate research into the university curriculum? Are undergraduate students mature enough to think, implement, and reflect on research results?

The Setting in Portugal

In Portugal, there are no organizations or government agencies that advocate for undergraduate research, unlike the availability for graduate research students from masters and PhD level degrees. The principal Portuguese public agency, Foundation for Science and Technology (FCT), had a more robust budget in 2019 when compared with previous years. For the year 2020, it will have €631 mn (an increase of 11%, €62 mn, compared to the year 2018). This budget includes national funds as well as funds from the European community. The foundation aspires to direct significant funds into scientific jobs. Their goal is to hire 5000 PhD researchers over the next three years. Other parts of the budget finance the national research centers, research and development of scientific culture (€138 million euros), and advance teaching (€114.5 mn) to improve education at all levels. To promote international cooperation in the area of science and technology, the FCT will manage €57 mn; scientific computation and access to scientific publications will manage €20.6 mn. Regarding the advanced teaching, the foundation funded more than 1600 PhD scholarships in 2019 (Firmino 2018). For an easy reference, the reader can check the FCT website that lays out FCT organization, priorities, and programs, as well as the definition of international cooperation (https://www.fct.pt/apoios/cooptrans/index.phtml.en).

Portugal has a population of around 10 million people, and students pay the university fee (about €900 per year). However, there is currently a broad discussion to provide free education for all students. While research-oriented curricula are well organized at doctoral and masters level, introduction to academic research at the undergraduate level is undeveloped in

Portugal, as it has not yet been considered from a national policy perspective. The main goal of the FCT budget is to foster research at the PhD level rather than the undergraduate level.

According to Kinzie and Husic (2010), undergraduate research, done well, engages multiple dimensions of a student's cognitive, behavioral, and attitudinal skills. Some examples include task-specific learning about instruments and methods that flow into active hypothesizing and procedural troubleshooting. The development of these skills may result in increased self-confidence and independence that help shape the student's vision for the future. The undergraduate research experience is enriched by attaining research experience early and often. This argument has been demonstrated empirically and discussed by Madan and Teltge (2013) and also throughout a variety of disciplines, including engineering (Narayanan 1999), medicine (Murdoch-Eaton et al. 2010), biology (Reynolds et al. 2009), physiology (Desai et al. 2008), neuroscience (Frantz et al. 2006), psychology (Wayment and Dickson 2008), as well as in multidisciplinary discussions in prestigious journals (e.g., Carrero-Martinez 2011; Russell et al. 2007).

Kinzie and Husic also argue that undergraduate student participation in research is now seen by many as a way of developing leaders for the twenty-first century. By presenting their research to campus-wide audiences, to peers at national conferences, to scientists at disciplinary society meetings, and legislators at the state and national levels, students learn to communicate at several levels—including "nonexpert" audiences (in terms of scientific literacy). In addition to improving students' communication skills, dissemination activities also enrich the public understanding of science and allow students to become ambassadors for illuminating the importance of science and research in society (Kinzie and Husic 2010; Electronic version).

Should Portugal Offer Undergraduate Research?

As a first thought, we might agree with Kinzie and Husic, but more reflection about the subject is needed. Undergraduate students should be educated to think critically and be cognitively mature, but it is only at the masters and PhD levels when real research projects should be implemented. The developmental age of university students ranging from 18 to 21/23 years should be considered, including cognitive and physical maturity. Although undergraduate students can fully understand abstract concepts and are aware of consequences and personal limitations, one has to consider the different rhythms of human development and that some students reach maturity earlier than others (Almeida et al. 2000, 2003; Albuquerque 2008).

The period of adolescence shows critical transformations on neural development through neurochemical and morphological aspects. In the last decade, neurobiological research has shown that the neurological maturity of adolescence ends at 25 years of age (expected age of masters' students). New technologies of images made by magnetic resonance, which weren´t available a few years ago, have allowed the new research to progress. The typical behaviors of adolescence are cognitive impulsivity, emotional instability, and the desire for dangerous situations (Andrade et al. 2018). Our knowledge about the neurobiology behind these cognitive and behavioral changes has increased significantly with the arrival of magnetic resonance imaging (MRI), which allows unprecedented access to the anatomy and physiology of the living brain. Longitudinal studies with MRI begin to map the developmental trajectories of brain maturation and to explore the genetic and environmental influences on these trajectories in health and disease. Among the findings, obtained by neuroimaging, the one that says that the prefrontal cortex (an essential component of the neural networks involved in judgment, decision making, and impulse control) continues its maturation when the person reaches 25 years of age, had a great influence in the social, legislative, judicial, parental, and educational fields (Giedd 2011). Executive cognitive functions are processes that support many daily activities, including planning, flexible reasoning, focused attention, and behavioral inhibition, and demonstrate continuous development until early adulthood (Knapp and Morten 2013). A critical perspective for the development of these psychological skills is the structural and functional development of the brain, and one of the slowest developing brain regions is the prefrontal cortex, a large extension of the cortex located in the frontal half of the brain. What is remarkable about this region of the brain is that it continues to develop until the third decade of life (Knapp and Morten 2013).

Entry into higher education is a significant transition in a student's life, as it represents the possibility of continuing personal and professional projects. The student usually arrives at this educational level with strong expectations about the nature and characteristics of the academic context (Coelho et al. 2014). According to the literature (Albuquerque 2008; Almeida et al. 2003), it is during the first year of undergraduate courses when expectations about the university seem to dawn upon students, and significant adaptation difficulties appear, possibly resulting in academic failure. According to Almeida et al. (2000), the transition requires overcoming academic, personal, social, and vocational challenges. A study conducted by Fernandes et al. (2005) with 48 newly arrived students to the University of Minho, in the north of Portugal, revealed that many students evidence dilemmas on entry to higher education as well as severe symptoms that may reflect maladjustment and psychological distress associated with the challenging period and its new demands. So, teaching students how to do research should be designed at different developmental levels, regarding first-year students and senior students, like masters or PhD students. This is the scenario in Portugal, and I have no reason to believe teenage students' cognitive maturity should be so much different in other countries.

Universities should intentionally promote critical thinking in all science courses, aiming to achieve scientific integrity for students in the future. Building an excellent educational and scientific core foundation, providing space for growth, helping students to mature into adulthood with a stable psychological balance, and respecting the normal immaturity of university students, is more likely to develop competent researchers. How can we promote this growing process in students?

The Plea for Scientific Literacy: Connections Between Scientific Literacy, Scientific Thinking, and Critical Thinking

Faculty and mentors ought to encourage scientific and critical thinking in students, but how to do this? To think critically requires clarity, solid arguments, rigorous and systematic reasoning, based on scientific evidence. Melo (2016) suggests the following considerations might help teachers to develop critical thinking skills in students since teachers have a significant role in activating and modifying this critical thinking:

1. Identify fallacies in students' arguments, like wrong reasoning that nonetheless seems plausible.
2. Watch out for superstitions from students. Avoid assuming that events that happen sequentially have a causality relationship, before

forming conclusions, run out all possibilities from a situation. Know that coincidences do happen.

3. Study reliable and safe sources like scientific journals with high credibility.
4. Present graphics and statistics that are incomplete, regarding their sources and the percentage of the sample. Ask students to identify the problems.
5. Be intellectually honest and exude scientific integrity. Be accurate on acquiring, transmitting, and analyzing ideas. Don't make the mistake of hiding or demurring information just so that they corroborate your beliefs. Value the divergent results from a study. Arguments in favor and against should be analyzed rigorously and with no partiality involved. Honesty is essential so that science and the debate around it move forward. Go back to basics on this. If you think students already know that, it is never too much to mention this; especially in these fragile times that we are living in, concerning respect, values, morality, and honesty.
6. Have an open mind to new ideas, be ready to discuss the old ones, and look for different perspectives on the same subject. On evidence, be brave to change your opinion and admit it; that is being a good role model for students.
7. Promote questioning at every moment: introduce exciting questions throughout the classes and relate them to students' everyday life; you need to know their reality and know how to deal with problems when they occur.
8. Raise polemic themes that require students' positioning with arguments; facilitate them with respect and tolerance for different opinions.
9. Even in expositive classes, questioning and dialogue should be stimulated.
10. Help students to develop their ideas and construct their arguments in a logical and organized manner, giving them positive-negative-positive feedback. Teach students to build self-critical capacity. This is a significant skill of critical thinking, so it is essential to motivate students to analyze their speech, their arguments, guiding them when inconsistencies and incoherent sentences are found. This is when you can help to reassess some positioning and eventually change opinions/arguments, encourage the formation of new

positioning based on scientific evidence and not on preconceptions and biases.

11. Assist students in maintaining the focus on a subject, avoiding escapes from the theme being discussed.
12. Without venerating the Internet as the solution for the educational problems, contents from YouTube and TedTalks, for instance, if cleverly selected, can provide different points of view about a subject, increasing the debate and discussion in classrooms. For example, using YouTube videos about ethical and real problems and TedTalks can present a different point of view on a subject.

Let us now look at the definition of scientific integrity presented by Inserm (La science pour la santé/from science to health) by a team of researchers in France (Inserm 2019):

> *Scientific integrity is the truthful and honest conduct that must govern all research. Inherent to all research activities, it forms the basis of knowledge and learning. Scientific integrity is not a moral issue but is founded on universal moral principles according to which it is wrong "to lie, to steal,* etc.*" The quality and reliability of scientific output depend on it. The knowledge society is founded on it to—to put it succinctly—"believe in science." While ethical issues are debated, scientific integrity is indisputable. Scientific integrity is self-respecting; it is a code of professional conduct that must not be infringed. It is essential for science, in the same way as the professional codes of ethics are crucial for medicine and law.*

Research in the university curriculum should be organized for different levels of complexity in learning. As I see it in Portugal, the first three years of formation (undergraduate students) should include education in critical thinking and scientific integrity, parallel to the specific contents of each course. Building an ethical balance between the notions of personal gain versus common gain, educating for balance between rights and duties is a goal. If students have a solid education on this combination between rights and responsibilities toward research and society, they won't have ethical issues regarding the development of quality research results. If these notions are firmly developed in their curriculum, we can emphasize opportunities for observing, with a mentor, the research into real contexts where real problems occur that need solutions.

I agree with Kinzie and Husic (2010) when they suggest engaging students in the collection and analysis of original data with mentor supervision increases students' ownership of the research project over time, but only at the masters' level, not undergraduate. At the masters' level, students should be cognitively and emotionally mature enough to engage in real substantive matters with a solid bioethical foundation.

Professor Sally Hoskins (National Science Foundation support in USA 2003) presents a very interesting approach to develop undergraduate research with the method C.R.E.A.T.E. The C.R.E.A.T.E. (Consider, Read, Elucidate the hypotheses, Analyze and interpret the data, and Think of the next Experiment) method is a new teaching approach that uses intensive analysis of primary literature to demystify and humanize research science for undergraduates. The teaching/learning strategy developed and expanded in the United States with National Science Foundation support (2003–present) promotes the development of transferable analytical skills by focusing in-depth on a series of papers from a single research group. C.R.E.A.T.E. builds students' critical thinking and content integration abilities at the same time that it transforms their understanding of the research process and aspects of their epistemological beliefs (National Science Foundation support in USA 2003).

According to Kinzie and Huzic, a white paper published by The Teagle Foundation Working Group on the Teacher–Scholar (2007) approach, provides a concise argument for the robust connections and synergy between teaching and scholarship, at both undergraduate institutions and research universities. Fully embracing the pedagogy of discovery, inquiry, and analysis suggests the integration of teaching with research as opposed to separation. I agree with this argument. Still, it should not be applied as a real-world problem-solving project at the undergraduate level, only at the level of master's degree, as the Bologna Declaration upholds since 1999.

Imagine this scenario with three levels of research learning: students from the 1st cycle are juniors in research and observe the master students, learning by observation on how to design and implement research. And both these students work in cooperation with PhD students who are in real contact with real problems. The goal is to develop research skills and expand student mindsets to science and research, with a solid foundation on bioethical principles and supervised by senior students and faculty members. It not only enhances the problem-solving and analytical skills of the students but also promotes collaboration and teamwork among them

(Hati and Bhattacharyya 2018). The symbiosis established between students introduces them to the joys of discovery as well as lessons in persistence, problem-solving, and critical thinking (Kinzie and Husic 2010).

Education in the twenty-first century must be updated, and we need to look for an understanding that transcends the classroom, but there is still a lot to be done inside the classroom. In particular, we need to find a balance between practical and theoretical concepts.

Worldwide, there are complex and global challenges like climate change, energy usability, and especially world health in elderly people. Also, on another spectrum of reality, as Damásio (2019) stated, social networks are disturbing the political process in a considerable way, such as the rapid and massive access to bad information (not well analyzed) is a considerable risk. Human life will be less respected when considering human values. These challenges will most certainly involve multidisciplinary perspectives that need many soft skills like finding common ground of communicating with different scientific areas, managing different arguments, mediating different personalities and, most importantly, supporting and representing scientific integrity within a culture of reliability, conducting responsible research. Kretser et al. (2019) present the result of a scientific integrity consortium, where they developed a set of recommended principles and best practices that could be used broadly across scientific disciplines as a mechanism for consensus on scientific integrity standards. The authors (Kretser et al. 2019) present two main principles under which scientific processes should operate: (1) foster a culture of integrity in the scientific method and (2) evidence-based policy interests may have legitimate roles to play in influencing aspects of the research process. Still, those roles should not interfere with scientific integrity.

Critical Thinking and Scientific Integrity: Are Undergraduate Students Ready to Adopt It?

Yes, but let's help them grow first. Kretser et al. (2019) argue about nine best practices for instilling scientific integrity:

I. Require universal training in robust scientific methods, in the use of appropriate experimental design and statistics, and in responsible research practices for scientists at all levels, with the training content regularly updated and presented by qualified researchers.

II. Strengthen scientific integrity oversight and processes throughout the research continuum with a focus on training in ethics and conduct.
III. Encourage reproducibility of research through transparency.
IV. Strive to establish open science as the standard operating procedure through the scientific enterprise.
V. Develop and implement educational tools to teach communication skills that uphold scientific integrity.
VI. Strive to identify ways to strengthen the peer review process further.
VII. Encourage scientific journals to publish unanticipated findings that meet standards of quality and scientific integrity.
VIII. Seek harmonization and implementation among journals of rapid consistent and transparent processes for correction or retraction of published papers.
IX. Design rigorous and comprehensive evaluation criteria that recognize and reward the highest standards of integrity in scientific research.

Should we demand that new undergraduate students, facing so many personal developmental challenges, be ready to think, implement, and analyze in a mature and scientific way, research results? Are they prepared to face our global society, communicate science to decision-makers? Although some communities of researchers have proposed that early undergraduate research experiences that are grounded in incoming students' experiences and communities are effective means of student growth and development, it seems wiser to implement first, a culture of scientific integrity, and then demand quality and a scientific attitude from students, concerning the design, implementation, and examination of scientific results. Studies of Vygotsky (1981), about development and learning processes, have made an essential contribution to the educational field. All the initial learning processes benefit from significant social experiences, with the mediation of other persons with whom the individual can interact, whether adults or peers. This is very important so that the learning of new concepts can happen smoothly and regularly. Let's not rush the development of university students. The world has considerable problems to be addressed. Political and social issues are directly related to science and research and, in that sense, an overview of considerations about struggles in Portugal, Europe, and the world is presented next in order to conclude why it is so important to have a solid education on ethics and research principles.

Portugal is part of the European community, and the European integration has operated, during the past decades, as a safe harbor of peace, respect for human rights, defense of democracy, endowing well-being, supporting the free circulation of citizens, analogous to opening frontiers to hospitality and receiving citizens from third-world countries. All this occurred on behalf of the agreement of Schengen (Official Journal of the European Communities 2000). The European community has also been, since its foundation, a space of construction of shared citizenship and development of global ecological consciousness (Carta Pastoral 2019). We are facing global problems like biological diversity, climate variability, health issues, elderly health care, social migration, and social integration. At this moment, we are witnessing movements of disintegration in the European Union, like Brexit (i.e., the exit of the United Kingdom out of the European Union, cf. Wikipedia for more political detailed information) and the increase of national authoritarian movements, parallel to a rise of xenophobic statements. The intolerance toward different cultures seems to be increasing. Scientific teams from all fields should embrace this problem genuinely when supporting the fact that students from master or PhD courses present an attitude of scientific integrity. Undergraduate students should be part of these research teams, observing the senior's approach. These teams should promote solutions that contest an environment of physical, verbal, and psychological violence, and promote, instead, cooperation, solidarity, and economic and social guidelines. In particular, science should mainly aim to increase social cohesion between different social classes and support their findings keeping in mind the sustainability of a more fair-minded society. A study from Organization to Cooperation and Economic Development (OCDE), entitled *In it* together—why less *inequality benefits all* (May 2015) shows how the levels of inequality are the highest in the last 30 years. In the 1980s, in the last century, the proportion of resources from the 10% wealthiest people and the 10% poorest, was from 1 to 7. Today is from 1 to 10. These issues demand cognitive and emotional maturity and the scientific integrity of students/researchers. Science goals, in all scientific fields, should aim to help human beings and target for a better future, where research communities contribute to a more nondiscriminatory and just society.

References

Albuquerque, T. (2008). Do abandono à permanência no ensino superior. *Revista Ciências da Educação, 7*(1), 19–28. Available at http://dialnet.unirioja.es/servlet/articulocodigo1/42795158.4

Almeida, L., Soares, A., & Ferreira, A. (2000). Transição e adaptação à Universidade: Apresentação de um questionário de vivências académicas (QVA). *Psicologia, 14*(2), 189–208. Available at http://repositorium.sdum.uminho.pt/handle/1822/12069

Almeida, L. S., Gonçalves, A., Salgueira, A. P., Soares, A. P., Machado, C., Fernandes, E., Machado, J. C., & Vasconcelos, R. (2003). Expectativas de envolvimento académico à entrada da Universidade: Estudo com alunos da Universidade do Minho, *Psicologia: Teoria. Investigação e Prática, 8*(1), 3–15.

American Council of Learned Societies. (2007, May). *Student learning and faculty research: Connecting teaching and scholarship*, A Teagle Foundation white paper.

Andrade, A. L. M., Bedendo, A., Enumo, S. R. F., & Micheli, D. (2018). Desenvolvimento cerebral na adolescência: aspectos gerais e atualizaçao. *Adolesc Saude, 15*(Supl. 1), 62–67. https://s3-saeast1.amazonaws.com/publisher.gn1.com.br/adolescenciaesaude.com/pdf/v15s1a08.pdf

Carrero-Martinez, F. A. (2011). Rethink summer student research. *Science, 334*, 313.

Carta Pastoral. (2019). Um olhar sobre Portugal e a Europa à luz da doutrina social da Igreja. In *Conferência Episcopal Portuguesa*, Fátima, Portugal.

Coelho, C., Faria, C., Oliveira, F., Lucas, C. V., Vasconcelos, S., & Soares, L. (2014). Pilot project for peer tutoring: A case study in a Portuguese university. *Journal of Applied Research in Higher Education, 6*(2), 314–324. ISSN 2050-7003.

Damásio, A. (2019, June 8). Interview to journal *Expresso*. Retrieved on December 13, from https://expresso.pt/sociedade/2019-06-08-As-redes-sociais-estao-a-prejudicar-a-qualidade-de-vida.-Palavra-do-neurocientista-Antonio-Damasio?fbclid=IwAR0oO2Q83Gl0Y4z_tDbb9Se23F02Cu-y-kPWBF8qSpXbd_tWsSVlaP1Tbks

Desai, K. V., Gatson, S. N., Stiles, T. W., Stewart, R. H., Laine, G. A., & Quick, C. M. (2008). Integrating research and education at research-extensive universities with research-intensive communities. *Advances in Physiology Education, 32*, 136–141.

Fernandes, E., Maia, A., Meireles, C., Rios, S., Silva, D., & Feixas, G. (2005). Dilemas implicativose ajustamento psicológico: um estudo com alunos recém-chegados à Universida deMinho. *International Journal of Clinical and Health Psychology, 5*(2), 285–304.

Firmino, T. (2018). FCT vai ter um dos maiores orçamentos de sempre. *Jornal o Público*. Retrieve https://www.publico.pt/2018/10/16/ciencia/noticia/fct-vai-ter-um-dos-seus-maiores-orcamentos-de-sempre-1847676.

Frantz, K. J., DeHaan, R. L., Demetrikopoulos, M. K., & Carruth, L. L. (2006). Routes to research for novice undergraduate neuroscientists. *CBE Life Sciences Education, 5*, 175–187.

Giedd, J. N. (2011). Maturação do cérebro adolescente. In *Enciclopedia sobre desenvolvimento da primeira Infância*, Eletronic version. Retrieved on March 16, 2020, from http://www.enciclopedia-crianca.com/cerebro/segundo-especialistas/maturacao-do-cerebro-adolescente

Hati, S., & Bhattacharyya, S. (2018). Integrating research into the curriculum: A low-cost strategy for promoting undergraduate research. In *Best practices for supporting and expanding undergraduate research in chemistry*, *ACS symposium series, 8*(1275), 119–141, ISBN13: 9780841232846, ISBN: 9780841232839. https://doi.org/10.1021/bk-2018-1275.ch008.

Inserm. (2019). La science pour la santé/From science to health. *Assessment and proposals for the implementation of the national charter of scientific integrity*, by Pierre Corvol with the participation of Rémy Giscquel (2016 in French). Retrieved on July 29, 2019, from https://www.inserm.fr/en/research-inserm/scientific-integrity

Kinzie, J., & Husic, D. (2010). Research and discovery across the curriculum. *Peer Review*, 12, 2. Retrieved July 16, 2019, from (Electronic version) https://www.aacu.org/publications-research/periodicals/research-and-discovery-across-curriculum

Knapp, K., & Morten, B. J. (2013). Desenvolvimento do Cérebro e Funcionamento Executivo. In *Enciclopedia sobre desenvolvimento da primeira Infância*, Eletronic version. Retrieved on March 19, 2020, from http://www.enciclopedia-crianca.com/funcoes-executivas/segundo-especialistas/desenvolvimento-do-cerebro-e-funcionamento-executivo

Kretser, A., Murphy, D., Bertuzzi, S., Abraham, T., Allison, D. B., Boor, K. J., Dwyer, J., Grantham, A., Harris, L. J., Hollander, R., Jacobs-Young, C., Rovito, S., Vafiadis, D., Woteki, C., Wyndham, J., & Yada, R. (2019). Scientific integrity principles and best practices: Recommendations from a scientific integrity consortium. *Science and Engineering Ethics, 355*(25), 327. https://doi.org/10.1007/s11948-019-00094-3.

Madan, C. R., & Teltge, B. (2013). *The benefits of undergraduate research: The student's perspective, 15,* electronic version. https://doi.org/10.26209/MJ1561274. Retrieved December 18, from https://journals.psu.edu/mentor/article/view/61274/60907

Melo, A. S. (2016). Seis maneiras de estimular o pensamento critico. *Universo Racionalista*. Retrieved December 13, from https://universoracionalista.org/seis-maneiras-de-estimular-o-pensamento-critico/

Murdoch-Eaton, D., Drewery, S., Elton, S., Emmerson, C., Marshall, M., Smith, J. A., & Whittle, S. (2010). What do medical students understand by research and research skills? Identifying research opportunities within undergraduate projects. *Medical Teacher, 32*, e152–e160.

Narayanan, R. M. (1999). Use of objective-based undergraduate research project experience as a graduate student recruitment tool. *Journal of Engineering Education, 88*, 361–365.

National Science Foundation support USA. (2003–Present). *C.R.E.A.T.E.* (*Consider, Read, Elucidate the hypotheses. Analyze and interpret the data, and Think of the next Experiment*, July 2019). Retrieved on July 18, 2019, from http://www2.cuny.edu/research/student-resources/for-faculty/integrating-research-into-the-curriculum/

OECD. (2015). *In it together: Why less inequality benefits all.* Paris: OECD Publishing. https://doi.org/10.1787/9789264235120-en.

Pacheco, J. A. (2003). Políticas educativas para o ensino superior na União Europeia: Um olhar do lado português. *Educação e Sociedade, 24*(82), 17–36.

Reynolds, J., Smith, R., Moskovitz, C., & Sayle, A. (2009). BIOTAP: A systematic approach to teaching scientific writing and evaluating undergraduate theses. *Bioscience, 59*, 869–903.

Russell, S. H., Hancock, M. P., & McCullough, J. (2007). Benefits of undergraduate research experiences. *Science, 316*, 548–549.

Schengen Agreement. (2000). Convention implementing the schengen agreement of 14 June 1985. *Official Journal of the European Communities*, 19–62. Retrieved on December 13, 2019, from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:42000A0922(02)&from=EN

Vygotsky, L. (1981). The genesis of higher mental functions. In J. V. Wersch (Ed.), *The concept of activity in soviet psychology* (pp. 144–148). Armonk: M.E. Sharpe.

Wayment, H. A., & Dickson, K. L. (2008). Increasing student participation in undergraduate research benefits students, faculty, and department. *Teaching of Psychology, 35*, 194–197.