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About the Journal

Science Education and Civic Engagement: An International Journal is an online, peer-reviewed journal. It publishes articles that examine how to use important civic issues as a context to engage students, stimulate their interest, and promote their success in mathematics and science. By exploring civic questions, we seek to empower students to become active participants in their learning, as well as engaged members of their communities. The journal publishes the following types of articles:

- ***Book & Media Reports***
- ***Point of View***
- ***Project Reports***
- ***Research***
- ***Review***
- ***Science Education & Public Policy***
- ***Teaching & Learning***

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From the Editors

For the Winter 2021 issue of this journal, we are delighted to feature a research article and an extensive book review. These contributions reflect a variety of creative connections between science education and civic engagement.

Jackson Miner and **Rona Robinson-Hill,** both at Ball State University, examine the impact of integrating feminist pedagogies into secondary science education. Drawing on a rich interview with an African-American female scientist, who teaches a secondary education science course at a predominantly White institution, this research article explores how inclusionary feminist principles influenced the pedagogical development of pre-service teachers. The outcomes of the project included a commitment to representation, recognition and discussion of bias, and motivation for reconceptualizing lesson plans and teaching philosophy. The authors provide a valuable case study for using inclusive educational principles to broaden interest in science among students and teachers.

The second contribution to this journal issue is a book review essay from one of us (**Matthew A. Fisher,** Saint Vincent College) that discusses how various authors are analyzing our current experiences with the COVID-19 pandemic. Ranging from scientific principles to public policy, these books provide insights into the origin, spread, and impact of the novel coronavirus. A common theme in several of these books is the systemic failure to mount an adequate response to containing COVID-19, which has now caused more than 2 million deaths worldwide. The book review concludes with references to works of fiction and poetry, which provide a literary lens for processing the personal and societal toll of the pandemic.

We wish to thank all the authors for sharing their scholarly work with the readers of this journal.

Matt Fisher
Trace Jordan
Co-Editors-in-Chief

RESEARCH PROJECT

Integrating Feminist Pedagogy into Science Teacher Education

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Abstract

With a growing need to give underrepresented populations equitable opportunities in science, less traditional pathways for science instruction must be considered. Incorporation of feminist pedagogies into secondary science teacher education provides an opportunity for pre-service teachers (PSTs) to help underrepresented minority groups connect to and build an interest in science. A civic engagement project was designed for undergraduate students in a capstone course in a Women and Gender Studies program, in which students were charged with identifying and interviewing a person in their dream career who was involved in feminism. This paper discusses the responses from an interview with a secondary science education methods professor with an intersectionality as an African-American female scientist in a predominately White institution in the Midwest. The interview focused on how different feminist principles affected her goals for the science education courses she teaches, and included a critical analysis and discussion of activities completed in the secondary methods course. In this paper we discuss how a secondary science methods course grounded in inclusionary feminist principles led to the development of activist pre-service science teachers with a commitment to representation and to recognition and discussion of

bias. The data supporting the project are excerpts from the interview questions as well as specific activities implemented in the secondary science methods course that influenced the first author's lesson plan development and philosophy of teaching. Clearly, experiences for PSTs that are grounded in exposure to and awareness of pre-service teacher activism, representation, and recognition and discussion of bias are necessary if we are to create equitable opportunities and to foster an interest in science that is accessible to all students and teachers.

Keywords: feminist pedagogy, secondary pre-service teachers, activism, secondary science education, feminism, inclusion, diversity, STEM

Introduction

The purpose of this paper is to discuss how incorporation of feminist pedagogies and principles such as representation, recognition, discussion of bias, and science educator activism in a secondary science methods course provides a framework for future science educators. The current demographics of the STEM workforce reveal that Black and Hispanic workers are underrepresented, and this indicates a need to ensure that STEM pedagogy is made available to underserved students (Funk & Parker, 2019). Teachers are on the front lines when it comes to encouraging and fostering student interests and must therefore be prepared to meet the diverse needs and experiences of the students in their classrooms. In science education, minority representation is lacking in both the curriculum and in those who teach it. Over 90% of science educators are White, and in the progression from middle school to high school, the percentage of female teachers in science drops from 70% to 54% (Wilson, Schweingruber, & Nielsen, 2015).

Uplifting the next generation of scientists and science educators starts with breaking the cycle of traditional teaching methodology, in which White teachers are prepared to inspire only White students. This shift can occur through applying feminist pedagogy to science education. Many feminist scholars of science education desire a change in how and what students are taught—with a shift in favor of inclusive practices and curricula that encourage underrepresented populations to connect and thrive in science (Brotman & Moore, 2008; Capobianco, 2007; Richmond, Howes, Kurth, & Hazelwood, 1998). Another feminist scholar Karan Barad (2001, p. 237) argues that most scientific literacy projects have failed because society is so scientifically illiterate and believes that scientific literate information is irrelevant. Thus, attempting to help students see science as significant to their lives is paramount and requires practices that fully engage them with the nature of science as a social process (Barad, 2001). This feminist and African-American professor attempted to move toward these goals in her secondary science methods course. The project, called the Training Future Scientist Program (TFS), is embedded in a secondary methods course using culturally responsive teaching and feminist pedagogies to explore how these pedagogies can influence traditional White secondary science pre-service teachers (PSTs) who will teach secondary students during student teaching and in their future classrooms.

This paper highlights how integration of feminist pedagogy into a secondary science methods course will prepare secondary PSTs with the skills they need to foster a passion for science in all students. Using this pedagogy will equip these future secondary school teachers with the tools they need to motivate students who are often underrepresented in the STEM curriculum and in the STEM workforce. For our discussion, "underrepresented" includes both females and students of diverse ethnic groups.

Feminist Pedagogy in PST Education

There are many different approaches to the incorporation of feminist pedagogy into science education. Broadly defined, "the tenets of feminist praxis [are combined] with the principles of science teaching" (Barad, 2001, p. 3); at its core, feminist pedagogy focuses on utilizing educational practices that support the diverse needs and experiences of all students, while examining and dismantling the biases within the current educational system (Capobianco, 2007). Examples range from (a) incorporating practices that encourage more female participation and (b) utilizing methods with an emphasis in activism, to (c) analyzing what aspects of science education are currently excluding women and minorities (Capobianco, 2007). Teo (2014) reports newer approaches toward feminist studies

in science education that focus on activism, in which feminist principles like intersectionality, identity, and positionality are used to empower students to take control of their understanding of science. Jackson and Caldwell (2011) attempted a project for non-major biology students that coupled the Science Education for New Civic Engagements and Responsibilities (SENCER) approach with feminist pedagogy. The goal of this project was to encourage students to (a) investigate the production of knowledge, (b) participate in construction of knowledge, and (c) apply these skills to issues requiring civic engagement and responsibility. Through the connection of civic importance to science information, many students gained increased confidence and engagement with the material (Jackson & Caldwell, 2011). Our goal of implementing feminist pedagogy in PST education is similar to the goals of the Jackson and Caldwell project, and includes making the content and connections meaningful and relevant to students and their community.

Our idea of feminist pedagogy for PST education draws upon all students' interests, experiences, and preconceptions. We want to validate the voices and experiences of all, while challenging oppressive practices and structures that are currently in place, in order to eliminate the historic inequity found within the education system (Capobianco, 2007). With that foundation, our PST education would incorporate the following four approaches presented by Brotman and Moore (2008) in an effort to engage underrepresented populations more effectively and meaningfully in science: (a) equity and access (the need to eliminate inequities and provide equitable science opportunities in the classroom), (b) curriculum and pedagogy (changing what is taught to include the experiences, learning styles, and interests of all students), (c) reconstructing the nature and culture of science (changing how science is viewed and defined in school and society), and (d) identity (encouraging all students to incorporate science as a component of their identity) (Brotman & Moore, 2008).

Description of the Interview

For a capstone course in a Women and Gender Studies program, the students were given the following charge: *Identify and interview a person in your dream career involved in feminism.* The first author selected the second author, a Black female secondary science methods assistant professor, because the experiences he had in her secondary science methods course and her research interests published on the university's website included "[providing] authentic science instruction to underrepresented students in grades K-5, by preparing elementary science PSTs in SCI 397" (Ball State University, 2020). This decision led to an interview and post-interview discussion concentrated around how science methods courses can authentically prepare PSTs to recognize and discuss bias, as well as to promote inclusivity in their future classrooms.

The interview included seven questions to reveal how feminist principles including diversity, inclusion, ethnicity, and gender contributed to her pedagogical reasoning. The questions were as follows:

1. What influenced your decision to become a science educator?
2. When and how did you develop an interest in creating a more positive space for underrepresented students in science classrooms?
3. What do you believe are the biggest issues schools are facing in terms of inclusion and diversity?
4. What are your recommendations for how science teachers can get more students, especially minority students, interested in further pursuing science?
5. How have race/ethnicity and gender impacted your goals and career path up to this point?
6. Do you consider yourself a feminist? Do you consider your work to be contributing to feminism?
7. If you could offer two pieces of advice to future science educators looking to pursue a similar pathway (i.e. increasing diversity in the science education classroom, getting more minority/ underrepresented students interested in science,…etc.) what would they be?

Following the interview, four projects that highlighted feminist principles the first author participated in while in the second author's secondary methods course were also discussed. Brief summaries of the projects are provided below.

- **"Shadow-A- Scientist":** Each student identified a STEM research interest, chose a scientist at the

university to shadow and spent a minimum of 12 hours working alongside the scientist in their research lab.

- **DAST (Draw-a-Scientist Test):** Each student drew a scientist and chose a skin-colored crayon to shade in the reverse side of the image. An analysis and discussion of the images drawn, and colors chosen followed the assignment.
- **Black History Month Bingo:** Trivia presented during each class throughout the month of February educated students about prominent African Americans across many different career fields. Students actively participated in discussion and in a process of determining the identified person on their bingo board.
- **Precision versus Accuracy Lab:** Students were given a ruler and a block and asked to take measurements of the length, width, height, and volume. The measurements were compared to the expected results, followed by a discussion of why discrepancies occurred.

Outcomes of the Interview

Analysis of the responses to the interview questions and the activities completed in the course revealed three major themes that should be addressed in PST science methods courses. These themes include representation, recognition and discussion of bias, and creation of activist science educators.

Representation

In the interview, the following responses involved representation:

Responses

1. *"I was the first African American and female to earn a Ph.D. in my program and I am the first African American to pursue a tenure-track position in the biology department at BSU. So, a lot is riding on my success so I have to make it so others know they can do it."*

2. *"My ethnicity and gender have provided me access since being an African-American female places me in a diverse and marginalized group to earn a Ph. D. and work at a predominantly white university."*

3. *"Most of my work focuses on reducing the fears of White female PSTs to teach underserved diverse groups with confidence and competency.… I am producing teachers that are not afraid to work with diverse underserved groups."*

In her responses, Dr. Robinson-Hill focuses on how representation has affected her life firsthand (Response 1 & 2) and on the positive impact she is trying to make within the education system (Response 3). The experiences she has had throughout her career have allowed her to recognize the changes needed to create PSTs who are not only prepared to teach underrepresented groups (Response 3) but who can also inspire them to pursue careers in STEM themselves. Women and other underrepresented groups are often disinclined to choose careers in STEM because of the lack of role models (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001; Brickhouse, Lowery, & Schultz, 2000). Thus, having a Black and female professor for this secondary science methods course could potentially impact both underrepresented demographics of PSTs and inspire their future students to pursue a career in STEM. Boumlik, Jaafar, and Alberts (2016) have alluded to the important influence that role models in higher education can have on students' future academic and career choices. Research has also shown that a more diverse population of science educators can encourage PSTs of color to be more committed to multicultural teaching, social justice, and providing children of color with academically challenging curriculum (Sleeter, 2001, p. 95). Thus, diverse PST educators could lead to a more diverse population of teachers: the cyclical advancement begins when students also learn and connect to STEM because they see themselves represented (Brickhouse et al., 2000).

With her understanding of the need for representation in PST education courses, the second author implemented two activities mentioned above, "Shadow-A- Scientist" and Black History Month Bingo. Incorporation of the "Shadow-A-Scientist" project allow PSTs to be paired with professionals and share in an authentic and positive research experience. This firsthand research experiment and mentorship can affirm PSTs' commitment to pursuing careers in STEM, as it did for the first author. Estrada, Hernandez, and Schultz (2018) have also shown that authentic science research and mentorship have a

positive impact on underrepresented minorities who pursue STEM careers, and thus, recreating this experience in the PST's future classroom, can provide students with a reciprocal learning opportunity. The other representation activity, Black History Month Bingo, can serve as both an implicit and an explicit representation instructional activity, focused on highlighting the achievements and exceptionalities of hidden figures in a minority community. The adaptability of the activity for other meaningful cultural awareness months, including LGBTQ Pride, Women's History, Hispanic Heritage, and more, allows for in-depth coverage of many areas of diversity.

Recognition and Discussion of Bias

In the interview, the following responses involved recognition and discussion of bias:

Responses

1. *"What influenced me to become a science educator were the fears I saw in many of the White female teachers that were hired by my school district in STL. I felt I had the secret to their success in my tool belt, so I decided to leave secondary education and become a professor to train future teachers in grades K-12 that desire to work with underserved diverse groups."*

2. *"My desire to create a positive space for underserved students in science classrooms was to motivate these students to want to do science by allowing them a space to do science without being judged if they did not get the right answer."*

In further discussion of her responses, Dr. Robinson-Hill said that the secret to the success she had with her White female PSTs (Response 1) was providing them with an education grounded in authentic learning experiences coupled with activities preparing them to work and learn with underserved students. Many White PSTs do not understand the level of inherent bias and discrimination, especially regarding race/ethnicity (Sleeter, 2001). The DAST activity brought this phenomenon of inherent bias to light by exposing the stereotypes we hold about those who pursue science. As seen in other studies, even at a young age many students hold masculine ideals of a scientist (Brotman & Moore, 2008). The other bias that was analyzed by this activity was ethnicity. The crayons chosen represented skin tones, and the first author, as did much of the class, chose a color that closely resembled his own skin tone. This in combination with the drawings, allowed for an in-depth discussion about our subconscious association with things that are similar and how to be cognizant of our own inherent biases around gender and ethnicity.

Bias can be seen outside of gender and racial categories as well, as is exemplified by the Precision versus Accuracy lab. The Precision versus Accuracy lab addressed assumptions and misconceptions in science education regarding previously obtained knowledge. Even though using a ruler is a presumed basic skill, this activity revealed to the first author the diversity of knowledge on how to read and use a ruler, and thus the possibility for misunderstanding and confusion. This experience resulted in the first author's recognition of the inherent value of beginning a lesson with a basic fundamental skill review that provides every student an equitable foundation. Dr. Robinson- Hill mentioned in their discussion how the Precision versus Accuracy lab was so important in creating the infrastructure for success in a science classroom. Through this activity, Dr. Robinson-Hill instilled in the first author the need to provide students the opportunity to learn—no matter what their previous background knowledge—while supporting them through success and failure without judgement (Response 2). Creating an equitable base for all students to build their knowledge upon while thwarting biases is a central approach of our feminist pedagogy.

Creation of Activist Science Educators

In the interview, the following responses involved the creation of activist science educators:

Responses

1. *"The biggest issue we are facing in schools in terms of inclusion and diversity is the lack of access to authentic science instruction for diverse populations of students."*

2. *"Some possible recommendations for how science teachers can get more diverse students interested in pursuing science is allowing them access to*

inquiry-based science in their schools, then access to authentic science experiences in the summer at BSU and other universities."

3. *"Two pieces of advice I would give to future science education majors would be: 1) to make sure you advocate for diverse students in your school to have access to science and science enrichment opportunities: and 2) make sure you stay connected to university researchers that are willing to invite secondary students and/or teachers into their lab to perform research."*

The theme of activism was present in Dr. Robinson-Hill's responses through her determination to provide her students, and especially her underserved students, with the best possible instruction, (Response 1 and 3). Teacher preparation programs that emphasized advocacy for students and families and incorporated it into fieldwork led to PSTs who were advocates both in and out of the classroom (Whipp, 2013). By getting more underrepresented students interested in STEM, we create growth in schools and in the community. When students of color choose to pursue STEM, the experiences are usually service oriented, affording these students with opportunities to volunteer and participate in their communities (McGee & Bentley, 2017).

Dr. Robinson-Hill also instilled authentic science opportunities through guided and open inquiry (Response 2). Inquiry-based lessons focus on student engagement and give students the opportunity to find solutions through individual input and collaboration. Inquiry lessons allow teachers to function as facilitators of high-quality prompts while not dominating the classroom conversation (Bulba, 2015). It is highly effective in conjunction with feminist pedagogy, where teachers function as collaborators, negotiators, and facilitators (Capobianco, 2007). This process can amplify student voices and provide associated mentorship, which leads to students' investing in and impacting their own education.

It was important to analyze the topics of representation and bias in order to allow the first author, a White male secondary PST, the chance to grasp the value of advocating for and becoming an activist educator for underrepresented students. Studies have shown that many White PSTs rarely discern discrimination, especially racism, and these challenges can then appear in the classroom (Sleeter, 2001). It has also been noted that many PSTs and in-service teachers have low efficacy in terms of teaching African-American children successfully (Sleeter, 2001). Discussion about representation, bias, and equity are essential if PSTs are to appreciate the needs of all students and thus properly educate and advocate for them. Having a secondary methods course that incorporates modeled activities with a basis in the three themes mentioned above allows for the success of PSTs, especially those who are White, in realizing the changes that need to occur within science education in order to influence underrepresented groups to enter. This realization also comes with understanding the importance of transferring the knowledge and skills learned in their teacher preparation programs to their future classrooms.

Conclusion

As a result of this entire process, the first author realized the value of connecting research to real-life practice. The meaningful connections in one-on-one conversations with professionals in the field can have a greater impact on teacher pedagogy than traditional classroom instruction. The interview was an epiphany in the first author's own understanding of science education and comprehension of the skills needed to improve as a future science educator. Boumik et al. (2016) found that perceptions of gender inequalities in the sciences are related to a person's attitudes and behaviors, and, especially if their culture is different from the majority culture, this can impact their viewpoint in specific sectors of STEM. Indeed, further research may show that inclusion of personal reflection and direct interaction with passionate secondary science methods professors could have a significant impact on skill development and the future success of secondary science PSTs. Potential outcomes from these relationships might include the creation of meaningful experiences, the ability to directly relate to students, and an opportunity to bring real-world meaningful experiences into the classroom.

About the Authors

Jackson Z. Miner is a graduate of Ball State University with a major in secondary life science education, a major in biology with a concentration in zoology, and a minor in women and gender studies. He is starting his career as a secondary science educator and has a passion for diversity, inclusion, and equity. Contact at jzminer@bsu.edu.

Dr. Rona Robinson-Hill is an assistant professor at Ball State University in Muncie, IN. Her research focuses on teaching and learning in elementary and secondary science methods courses, so that pre-service teachers learn how to reach underserved populations by using culturally relevant, inquiry-based pedagogy. She is the Principal Investigator of the Training Future Scientist (TFS) Program, which exposes elementary and second pre-service teachers to authentic pedagogy to reduce their fears about teaching science to diverse underserved students. This program provides instruction in inquiry-based elementary science teaching for diverse underserved students in grades K–5 and gives secondary science educators an opportunity to perform research in a STEM research lab. Contact at rmrobinsonhi@bsu.edu.

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REVIEW

Pandemic Reading Roundup

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For almost 12 months, we have been living through the worst pandemic in more than 100 years. During that time, much has been written about the SARS-CoV-2 virus and COVID-19, especially by journalists writing for various media; I have been particularly impressed by the work of Ed Yong *(The Atlantic)*, Kai Kupferschmidt *(Science)*, and Carl Zimmer *(The New York Times)*. But now we are seeing books being published on COVID-19, and it is some of those that I want to look at more closely.

Raul Rabadan's *Understanding Coronavirus* (Cambridge University Press, 2020) is designed, as the title suggests, to help the reader comprehend some of the basic science involved in the coronavirus pandemic. The publisher describes the book as "a concise and accessible introduction to all the science and facts you need to understand how the virus works." That turns out to be a good description of the book. Rabadan is a Professor of Systems Biology and Biomedical Informatics at Columbia, and he describes the book as his attempt to inform a general reader (one who has very limited knowledge of biology, virology, or epidemiology) about the basic science important to understanding the pandemic. In 94 pages, he provides an overview of the molecular biology and epidemiology of the virus, a little bit of genomics connected to SARS-CoV-2 origin and evolution, and comparisons to other respiratory viruses like influenza and the coronavirus responsible for the 2003 SARS outbreak. There is also a chapter at the end that looks at therapeutic options such as drugs or vaccines, although I found it much more dated and incomplete than other parts of the book. Readers interested in learning more about the vaccines currently being deployed will have to look elsewhere, as the

chapter's description of vaccines is restricted to general concepts applicable to any vaccine. My second criticism of the book is the small size of some of the graphics, particularly some that portrayed genomic relationships. The organization of chapters and subsections as a series of questions makes it easier for readers to find information. I'm not sure how easy it would be for the general public to understand everything in the book; to me it seemed that a background equivalent to college general biology would be needed to grasp all the ideas that Rabadan presents. But for STEM faculty, particularly those in biology or chemistry or environmental science, I see Understanding Coronavirus as a useful way to get basic background information on epidemiology and virology.

Apollo's Arrow: The Profound and Enduring Impact of Coronavirus on the Way We Live by Nicholas Christakis (Little, Brown Spark, 2020) and *COVID-19: The Pandemic that Never Should Have Happened and How to Stop the Next One* by Debora MacKenzie (Hachette Books, 2021) take very different approaches than Rabadan. Both Christakis and MacKenzie set out to contextualize the experience of the COVID-19 pandemic. Christakis is a physician and sociologist on the faculty at Yale, where his research, as described on his group's website, "focuses on how human biology and health affect, and are affected by, social interactions and social networks." Not surprisingly, he takes an expansive approach to understanding COVID-19, one that places the current pandemic in the context of how humans have responded to pandemics and disease outbreaks over the past 2500 years. *Apollo's Arrow* is wide ranging in the different aspects of the current pandemic that it examines. Medicine, public health, social interactions, network science, human psychology, economics, and policy are all explored in this book. The last two chapters look forward to how the pandemic may end and how global society was changed by the experience. But Christakis is not a dispassionate narrator simply describing the events that happened; throughout the book he incorporates sharp and appropriate criticisms of how governments and organizations responded to the COVID-19 pandemic. When I finished *Apollo's Arrow*, I felt that I had gained a much broader and nuanced understanding of how pandemics, including the current one, impact human lives and societies. I also realized that while humanity has in some ways made significant progress since the Black Death of the Middle Ages, in other ways we seem to make the same mistakes again and again.

MacKenzie is a European science writer who has written for The New Scientist for many years, including articles on the subject of infectious diseases. She uses a different framework for her overview of the COVID-19 pandemic, placing it in the context of how we deal with emerging pathogens. Her narrative of how the current pandemic unfolded is connected much more to recent outbreaks such as the 2003 SARS and Ebola outbreaks than is Christakis's book (although *Apollo's Arrow* does make some reference to the first SARS outbreak). She also incorporates how governments around the world and international organizations have tried (with widely varying degrees of success) to be prepared for future pandemics. Like Christakis, MacKenzie is very critical of what she views as mistakes and oversights that contributed to the severity and global toll of COVID-19. As the title *COVID-19: The Pandemic that Never Should Have Happened and How to Stop the Next One* suggests, the book also looks at what actions need to be taken on a global scale to ensure that the world is prepared for the next pandemic. MacKenzie makes it very clear in her book that the question is not "Will there be another pandemic?" The question is when it will happen, and will the pathogen be one that we have encountered in the past or a new one that will have jumped from an animal to humans.

I found both *Apollo's Arrow: The Profound and Enduring Impact of Coronavirus on the Way We Live* and *COVID-19: The Pandemic that Never Should Have Happened and How to Stop the Next One* well worth reading. For STEM faculty teaching courses with a focus on microbiology and emerging infectious diseases, MacKenzie's book may be slightly preferable. On the other hand, faculty teaching courses with a broader focus (courses for nonscience majors, first-year seminar courses) may find Christakis's book more useful. Personally, I'm happy that I have both of them on my bookshelf.

While Christakis and MacKenzie set out to describe what happened and contextualize the events of the COVID-19 pandemic, two other books are more focused on just the analysis. Richard Horton is the longtime editor of *The Lancet*, a British weekly medical journal that is one of the oldest in the world. In June, he published *The COVID-19 Catastrophe: What's Gone Wrong and How to*

Stop It Happening Again (Polity Press, 2020), which may be best described as a combination of analysis and polemic. The dictionary definition of polemic is "an aggressive attack on or refutation of the opinions or principles of another"; as a longtime advocate for the importance of global public health, Horton is well prepared to present an aggressive refutation of how the world responded to COVID-19. He uses as examples how different countries responded to the pandemic, although he provides more details about actions/inactions in the US, UK, and China. Consequently, reading Horton's book may help US readers develop a better sense of how similar or dissimilar government reactions to COVID-19 were in different countries. *The COVID-19 Catastrophe* doesn't go into as much detail about global responses to other pandemics as MacKenzie's book does. When Horton does make comparisons between COVID-19 and other pandemics, it is typically to the SARS outbreak of 2003 and what was learned from that. The book was published in June 2020 and presents Horton's scathing critique of government responses to COVID-19 in the first six months of the pandemic. In the last two chapters of the book, Horton looks at the implications of COVID-19 for society in general, particularly in regard to the problem of inequality. I found the argument and analysis in this section significantly less compelling than the earlier sections of the book. A major difficulty is that Horton's argument comes across as much more abstract, theoretical, and unevenly supported. Faculty may find the *The COVID-19 Catastrophe* worth reading as one person's analysis of the mistakes that were made and how countries should respond differently in a future pandemic, but I think there is significant overlap between this book and the one by MacKenzie.

In *The Pandemic Information Gap: The Brutal Economics of COVID-19* (MIT Press, 2020), Joshua Gans approaches the pandemic from the perspective of economics. A recurring theme in his analysis is that responding to COVID-19 is, in many ways, an information problem. How do we know who has been exposed, who is infected, and who is capable of infecting others? Another recurring theme is the challenge of balancing human health and economic activity. Separate chapters look at a number of different topics: viral transmission and human behavioral responses, communicating public health information, distributing resources that are limited in quantity, restricting physical movement, testing, re-emerging safely from periods of mandated lockdowns, and the role of innovation. The final chapter asks what we should learn from the COVID-19 pandemic and how that knowledge can inform future actions. As an economist, Gans's perspective on these topics is markedly different from, although not opposed to, what I routinely encounter in the scientific literature. As I read the book, I found myself thinking in new ways about aspects of the COVID-19 pandemic that students and I had talked about during 2020.

There are, however, two chapters where I felt Gans's analysis fell far short: the question of wearing masks and the role of innovation. In his discussion of the changing recommendations on wearing masks, Gans writes that "[w]e, the public, were played. And we were played by those whom we were supposed to trust implicitly because of their expertise." Harsh words, which Gans tries to justify in a footnote, where he writes:

> I use the word "played" to refer to the fact that experts gave advice to prevent mask adoption by claiming that there were no public health benefits from using face masks when there was ample evidence that masks would prevent the spread of infections prior to COVID-19.

However, I think Gans is ignoring two important things. The first is how our understanding of COVID-19 infection was rapidly changing in the spring. Aerosol transmission, now viewed as a significant mechanism for infection, wasn't initially understood as well as it is now. The extent to which transmission involved people who were asymptomatic was also becoming clearer. Gans also makes no mention of the mixed and often contradictory messaging coming from public health and government officials and the politicization of wearing a mask. I'm not suggesting that there isn't room to criticize how public health messages related to masks were conveyed to the general public. There is. But I found Gans's analysis of this topic flawed and incomplete. In a later chapter focused on the role of innovation in combatting the pandemic, Gans's analysis completely ignores how scientific research on SARS-CoV-2 and COVID-19 built on a combination of prior research on other viral diseases

(AIDS, Ebola, SARS) as well as the development of new technologies long before the COVID-19 pandemic. For example, RNA-based vaccines have been an area of active research for at least a decade and were being actively discussed before Gans's book was published in November 2020. But even with these flaws, I would recommend *The Pandemic Information Gap: The Brutal Economics of COVID-19* to faculty interested in seeing how another discipline approaches the challenge of a pandemic.

All of the books that I've described up to this point are works of nonfiction, most of them in the category of science writing. I want to finish this reflection on pandemic reading by encouraging faculty to spend some time also looking for works that are more creative in nature. In *The Integration of the Humanities and Arts with Sciences, Engineering, and Medicine in Higher Education: Branches from the Same Tree*[1], the National Academies of Science, Engineering, and Medicine encouraged faculty to continue efforts to integrate the arts and humanities with STEM in higher education. Such integration offers potential for increased student engagement and learning. Living through a pandemic certainly provides unique opportunities for such integrations. There are, of course, the obvious "classics": Daniel Defoe's *A Journal of the Plague Year* and Albert Camus' *The Plague*. But more recent works may also be of interest to faculty and students. Emily St. John Mandel's luminous *Station Eleven* is a novel set in a post-pandemic world that explores the idea embodied in the phrase "because survival is insufficient" (from a *Star Trek: Voyager* episode). Mandel's novel is wonderful exploration of the human spirit and ways we can bring meaning into our lives. *There Is No Outside: COVID-19 Dispatches* (published in June 2020) is a collection of essays that look at the experience of COVID-19 in a variety of contexts: prisons, emergency rooms, homeless encampments, migrant camps, and even in our homes. I will finish with two poems written in response to COVID-19. Paul Muldoon's "Plaguey Hill"[2] is set in a small village in central New York state but connects back to memories of the Plaguey Hill burial mound in Belfast, Ireland that contains the bodies of people who died in the cholera epidemic of the 1830s. Simon Armitage's "Lockdown"[3] connects an outbreak of bubonic plague in the English village of Eyam in the 17th century and the resulting quarantine to the experience of living in the UK during the COVID-19 lockdown.

List of Books Reviewed

Christakis, Nicholas A. (2020). *Apollo's arrow: The profound and enduring impact of coronavirus on the way we live.* Pp. 384. New York: Little, Brown Spark. ISBN 978-0316628211.

Gans, Joshua. (2020). *The pandemic information gap: The brutal economics of COVID-19.* Pp. 160. Cambridge, MA: MIT Press. ISBN 978-0262539128.

Horton, Richard. (2020). *The COVID-19 catastrophe: What's gone wrong and how to stop it happening again.* Pp.140. Cambridge: Polity Press. ISBN 978-1509546466.

MacKenzie, Debora. (2021). *COVID-19: The pandemic that never should have happened and how to stop the next one.* Pp. 304. New York: Hachette Books. ISBN 978-0306924248.

Rabadan, Raul. (2020). *Understanding Coronavirus.* Pp. 120. Cambridge: Cambridge University Press. ISBN 978-1108826716.

About the Author

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1 Summer 2018 issue of this journal (Vol 10 issue 2, pp 11-15)

2 Paul Muldoon's poem "Plaguey Hill" was published in the July 10, 2020 issue of the *Times Literary Supplement*.

3 Simon Armitage's poem "Lockdown" can be found at https://www.simonarmitage.com/wp-content/uploads/Lockdown-by-Simon-Armitage.pdf