

Embedding Activism in a STEM EdD Program

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ABSTRACT

This article shares an example of how one STEM EdD program embeds activism throughout their program. The authors share examples of readings and assignments across the program geared towards helping students think about and enact activism within the STEM disciplines. The STEM EdD mission offers insight into the foundations of the program. Then, specific examples from the following courses or course sequences are given: Action Research, Project-Based Learning, Research Methods in STEM Education, Advanced Readings in Mathematics Education, and Principles of Engineering in STEM Education. A conclusion offers some final thoughts about the ongoing development of the STEM EdD program to help our students grow as graduates who focus on equity and diversity in STEM education.

KEYWORDS

STEM, activism, EdD, doctoral programs

The capacity of the United States to remain innovative and prosperous depends on the development of an effective and inclusive STEM (Science, Technology, Engineering, and Math) education ecosystem (National Science and Technology Council, 2018). Regardless of the career path an individual takes, the ability to apply necessary STEM skills such as evidence-based reasoning is imperative for being an informed consumer and citizen. Vital to this aim is cross-collaboration among educators and professionals in the field. The push to enhance STEM Education across the nation has reemphasized the need to prepare STEM education professionals who can facilitate high-quality STEM education (Borrego, 2007). Educators also need professional learning to present STEM content in culturally appropriate ways to address the unique needs of non-white students (Gay & Howard, 2000; Leonard et al., 2010). Minority students (non-Caucasian) are among the fastest-growing demographics within the United States population and within public schools (Bureau, U.S.C, 2019) and remain underrepresented in STEM fields and STEM majors (National Center for Science and Engineering Statistics, 2019).

In response to this need, the University of South Carolina developed a STEM concentration within the existing Education Doctorate

Degree (EdD.) in Educational Practice and Innovation. Informed by the Carnegie Project on the Education Doctorate Consortium (CPED), this program aims to support the development of scholarly practitioners in K-12 education, who focus on investigating problems of practice in STEM Education. The STEM EdD degree develops an in-depth understanding of social justice in diverse communities and the desire to use equity pedagogies to address practice problems in educational settings. As part of the STEM concentration, candidates explore the theory, history, and concepts within STEM education settings and then apply these ideas to their research of practice. During the dissertation process, candidates will engage in action research related to STEM education and social justice. Given the need to prepare educators to teach all students, particularly those underrepresented in STEM disciplines of study and careers, faculty seek ways to engage themselves and their students in social activism (Underwood & Mensah, 2018).



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ACTIVISM IN STEM EDUCATION

Formal educational experiences set the foundation for individuals to connect knowledge (scientific and otherwise) within social activism (Lester et al., 2006). Integrating social activism across STEM education is key to developing scientifically informed and socially responsible youth and adults (American Association for the Advancement of Science [AAAS], 1989, 1993; National Research Council [NRC], 1996; National Science Teachers Association [NSTA], 1993). Within the context of STEM education, there is potential to develop students who engage in thinking critically about societal issues, take personal roles in solving societal issues, and influence the actions of others (parents, friends, relatives, neighbors, or local businesses) (Rahm, 2002). As teacher activism continues to develop throughout the country, ongoing research and teacher development, which directly addresses teacher activism specifically in STEM fields, is needed. Research about teacher activism points to the importance of gender, race, and personal experiences (Kokka, 2018). Teachers' beliefs on learner equity and social justice can be critical in affecting student-learning outcomes than any other measure of teacher quality (Quan et al., 2019; Burant, et al., 2007; Pajares, 1992). As such, teacher training programs need to engage teachers in becoming ethical and reflective professionals, rather than merely teaching professionals (Mehta, 2013). To achieve meaningful programmatic or institutional changes, the need to raise the awareness of social activism is vital for both teachers and students.

Faculty from the EdD program recently led a featured presentation at a convening of the CPED consortium in the Fall of 2019. Data generated during that session regarding how activism was defined, supported in CPED affiliated EdD programs, and how outcomes were measured was analyzed. This analysis led to the identification of 12 considerations that support EdD activism (Becton, et al., 2020). The 12 considerations are as follows:

1. Coursework Specific to Social Justice, Multicultural Education and/or Leadership.
2. Coursework Related to or Involving the Community.
3. Coursework Related to Research and/or Dissertation in Practice.
4. Overall Course Design.
5. Social Justice Related Focus for the Dissertation.
6. Inclusion of Student's Career and Professional Goals.
7. Considerations Relative to the Research and Writing of Dissertation.
8. Considerations for Dissertation Defense or Final Presentation.
9. Addressing Inequity in Institutions, Policies, Methodological Approaches, EdD. Programs (faculty and students).
10. Defined and Supported Dissertation Process.
11. Mentoring/Supporting Students and Graduates.
12. Scholarly and Practitioner Inquiry Activities. (Becton et al., p. 49, 2020)

With these 12 considerations in mind, we have intentionally designed a STEM education concentration that reflects these considerations and offers a new approach to developing STEM education professionals.

STEM EDD CONCENTRATION MISSION AND CURRICULUM

The STEM EdD concentration at the University of South Carolina follows the mission of our University and College of Education. As an affiliate of the CPED consortium, our fully online EdD program strives to develop scholarly practitioners who choose to engage in efforts to identify and resolve injustices and inequities in diverse educational contexts. The program seeks to foster a learning community that supports the growth of aspiring and practicing educators. Through purposeful interaction among faculty and students, the program emphasizes the active construction and application of knowledge, skills, and dispositions to promote educational excellence, equity, and opportunity in the 21st century. We honor our responsibility to contribute to the high achievement of all learners and the development of an educated populace. According to this responsibility, we are committed to developing and sharing our expertise and leadership while offering a forum for educational dialogue and advancement.

By bridging the gap among theory, research, and practice, we aim to promote excellence in teaching and learning within and across educational contexts. Through the enactment of principled, free inquiry from diverse perspectives that promotes quantitative and qualitative scholarship, we intend for our graduates to advance their knowledge and educational practice. By partnering with government agencies, P-12 educators, schools, districts, families, professional organizations, and other higher education institutions, we prepare educators to have a genuine understanding and appreciation of diversity as we challenge ourselves and others to work for social justice.

In order to develop ethical, reflective, and socially responsive education professionals, the STEM EdD program attends to issues of equity and promotes activism throughout the program. Each semester, students enroll in two, 8-week courses that run sequentially over a 16 week semester. The program has specific courses dedicated solely to issues of equity. One of these courses is Introduction to Diversity and Curriculum, which introduces students to the vast array of differences among children, youth, and adults, and the impact of these differences on the curriculum, their learning, and their social and emotional development. Additionally, students complete the Advanced Study of Diversity and Curriculum course, which explores the formulation and use of interpretive frameworks to study and understand the relationships among human diversity, school structures, and the curriculum. Although these courses directly focus on equity and social justice, the themes of activism and equity run across all of the courses offered in the STEM EdD. In the following sections of this paper, we describe the primary ways we promote and support activism among our students in our STEM EdD concentration and highlight how several of our 8-week courses focus on specific considerations thus ensuring alignment with our intention to promote the importance of issues of equity and the potential power of scholarly activism in our program's curriculum.

PRINCIPLES OF ACTION RESEARCH

Across all four of the concentrations in our College's EdD program, doctoral candidates plan and conduct a dissertation in practice to either investigate or directly resolve a persistent problem in their professional practice that is especially significant to themselves and local community members. Our EdD program

highlights action research (Herr & Anderson, 2015) as the preferred methodological approach for these dissertations in practice. Within our EdD curriculum, all four concentrations include two 8-week courses dedicated to developing theoretical and practical knowledge of action research. These two courses promote the identification of significant problems of practice that are either partially or thoroughly caused by injustices or inequities and provide our students with the methodological skills to investigate and resolve them through systematic and rigorous practitioner research.

Action research methodology differs in significant ways from more traditional forms of educational research. Whereas traditional forms of quantitative and qualitative educational research are primarily driven by researchers and generate knowledge for academic audiences, action research is driven by practitioners who aim to generate knowledge from research that is "grounded in educational practice" (Dana & Yendol-Hoppey, 2020, p. 5) for themselves and other practitioners. As such, the action researcher is a practitioner first and has established an insider positionality (Herr & Anderson, 2015) within the context of the study. Most often, the action research in which our students engage focuses on a problem of practice. These problems have either been present in the students' practice before enrollment in the program or have become apparent as their awareness of injustice or inequity in education deepens as a result of their progress in our program. Given the context-dependent nature of the problem and the researcher's insider positionality, the goal of action research in our program is squarely on improving the lived experiences for those community members who are either directly or indirectly impacted by the problem. Through a cyclical and collaborative process, action researchers intend to resolve the specific, real-world problems of practice encountered in a specific context. While this may not lead to filling gaps in the educational literature, the evocative power of practitioner research leads to transferable knowledge of, in, and for practice (Cochran-Smith & Lytle, 1999). As such, we believe action research at the doctoral level requires attendance to the underlying social and educational injustices that cause the problem.

In the two courses, Principles of Action Research and Advanced Principles of Action Research, faculty instructors first focus students on developing an awareness of and appreciation for identifying problems of practice that are, at their root, caused by systemic inequalities or injustices that permeate educational spaces. In so doing, the student begins their journey towards what we have come to describe as EdD-Activism. Given the 12 considerations for developing EdD-Activism we have identified previously (Becton et al., 2020), our action research courses reflect all 12 considerations but focus primarily on the considerations related to 1) understanding and differentiating the goals of traditional and practitioner research, 2) uncovering issues related to social justice in day-to-day practice, and 3) supporting the development of the written dissertation in practice.

In the first of the two action research courses, we begin with a focus on understanding the context-dependent nature of action research and how it is different from more traditional forms of research through an exploration and critical review of problems of practice used in previously completed dissertations in practice. Through this process, our students have developed indicators for assessing and critically analyzing the quality of a problem of practice for an action research dissertation. With each successive cohort that completes the first action research course, the indicators of quality get refined to be more focused and more useful for current and

future doctoral students in our program. This process of paying it forward connects our cohorts across years and demonstrates the power of collaboration and critical analysis, two essential attributes of an EdD-activist. The iterative development of these indicators of quality for various aspects of an action research study is one example of how our program promotes a more scholarly approach to action research, thus differentiating it from action research completed at the Masters or undergraduate levels of education.

Building on the more profound awareness of social justice our course sequence provides for our students, the second action research course revisits the problem of practice work with a more focused gaze on problems that emerge as a result of injustices in our educational system. The second action research course culminates with a focus on various practitioner research methods that allow the researcher to embed their data collection in the intervention or investigation process, thus minimizing any negative impact on the research participants' lived experiences. For example, our students often want to measure aspects of a student's perspective like their sense of belonging or level of collaboration, two constructs that are not easily measured directly. So, we will often suggest they use a short survey referred to as an *exit ticket* as a proxy for a more robust instrument. Exit tickets include a Likert-style survey item followed by an open-ended response item (see figure 1.).

Mrs. Johnson's Exit Ticket For Today									
Student Name _____									
How successful were you in class today?									
(Circle one number below)									
1	-	2	-	3	-	4	-	5	
not successful at all					very successful				
Why did you answer this way?									
How well do you feel you worked today?									
(Circle one number below)									
1	-	2	-	3	-	4	-	5	
not well at all					very well				
Why did you answer this way?									

Figure 1: Exit Ticket Example

Exit tickets can be done with paper and pencil or using a cloud-based digital form application. They are typically short and only require a few minutes of student time but can generate large amounts of useful data from the student perspective. Strategies for data collection that take very little if any student time away from the learning process is what we recommend as it aligns with action research's emphasis on equitable and ethical research in the



classroom. Exit tickets, and other methods of formative assessment that are both of and for learning (Kennedy et al., 2007) are topics of focus in the second action research course.

In both action research courses, the final assessments are pieces of writing that can either wholly or partially become portions of their written dissertations. Given that the action research courses occur at the beginning and end of the first year of the program, this writing typically contributes to the students' research proposal, the first of three critical benchmarks in our EdD program.

PRINCIPLES OF PROJECT-BASED LEARNING

As part of the STEM EdD program cognate (3-course sequence), students learn about and enact project-based learning (PBL) within their educational context. This three-course sequence was initially developed for a state-level licensure endorsement for teachers (Howard et al., 2015), and has been adapted for the STEM EdD degree. These courses focus on education professionals, and their use of project-based learning to engage K-12 students in local STEM-careers and community. Thus, this course sequence directly engages EdD students in activism consideration #2 by connecting K-12 students to their community to solve local problems or investigate local STEM issues and consideration #6 through the explicit connection of the PBL unit content to STEM careers. PBL engages students in activism, such as through social studies projects focused on civil rights and equity (Turk & Berman, 2018), service-learning projects (Stowe, 2020), or projects focused on improving local environmental issues (Herman, 2018; Rahm, 2002; Zimmerman & Weible, 2017). In the EdD program, STEM teachers can use PBL units to engage students in improving their local community while also introducing students to STEM career skills and content.

During the initial course, Introduction to Project-Based Learning, the EdD students learn about the gold-standard design elements that distinguish PBL instruction from regular classroom projects (Larmer et al., 2015). These design elements support student learning of content and 21st Century process skills (collaboration, critical thinking, and communication), which include: (a) a challenging problem or question, (b) sustained inquiry (c) authenticity, (d) student voice and choice, (e) reflection (f) critique and revision, and (g) a public product (Larmer, et al., 2015). The EdD students are also introduced to place-based education (Sobel, 2004) and link their PBL unit projects to local community problems or needs. These design elements work together to empower students to take ownership of their learning. For example, PBL elevates K-12 student voice when students choose project outcomes that benefit their school or local community. During a project, they might engage with local community members in sustained inquiry, interviewing local STEM content or community experts to learn new content and learn about local STEM career opportunities.

Additionally, they might present initial products to STEM experts and engage in a round of critique and revision before presenting their final products to an authentic audience. At the end of this first course, the EdD students develop a PBL unit that integrates STEM careers and local connections that they will teach and reflect on during the next course. Through the courses, teachers have developed PBL units that focus on school (developing a school garden or recycling program) or community level improvements (improving the ecosystem of a local park, engineering design projects in which students invent new products or artwork for their community). During the second course, Applications of PBL in

Curriculum and Instruction, the EdD students enact and reflect on their first unit and develop a second cross-disciplinary unit (must address more than one content area) that they teach in the final course. In the final course, Practicum in Project-Based Learning, the EdD students teach and reflect on their final unit and plan and engage colleagues in professional development around PBL. Thus, through the three courses, K-12 students are engaged in two PBL units in which they learn 21st Century skills, STEM content, and STEM career connections while also making a difference within and connecting further with the people and places in their local community.

IDENTIFYING AREAS FOR ACTIVISM IN STEM EDUCATION

The Research Methods in STEM Education (EDTE 812) course was developed as an online graduate course for the STEM EdD. This course is designed to engage students in critical exploration of current research and research methodological approaches in science, technology, engineering, and mathematics (STEM). Objectives in this course lend well to supporting activism among students, where students begin to identify areas of need. The ideas of action research developed and explored throughout this course, will lead to action research enacted within the students' community. Throughout the course, students explore research related to issues of social justice in STEM (i.e. STEM Career gaps, educational gaps, opportunity gaps). Through the lens of equity, students seek to identify local issues related to STEM education and propose an action research line of inquiry. In order to truly identify areas of need and support their line of inquiry, students engage in an in depth literature review on their selected issue and activism topic related to STEM.

Readings

Within the Research to STEM Education course, students engage in readings from the *National Science Foundations*, and The State of the U.S Science and Engineering 2020 (NSF, 2020) which enable students to look at the current state of Science and Engineering Education in PK-12 schools. Readings and exploration of the data include analysis of reports such as the Elementary and Secondary Mathematics and Science Education report (National Science Board, 2019). In addition to data and reports from the National Science Foundation, literature exploring barriers in STEM such as gender, race, and socio economic status are explored (Reilly et al., 2017; Gonzalez & Kuenzi, 2012; Chachashvili-Bolotin et al., 2016) along with readings from the course text, *Reconceptualizing STEM Education: The Central Role and Practices* (Duschel & Bismack, 2016). Course readings are discussed in depth and reflected upon with a critical lens. Students are asked to identify connections between the readings, national data, and their own communities and work with students and STEM Education (Activism Considerations 1, 2, 3, 5 & 9)

Assignments

Throughout the Research Methods in STEM Education course, students are engaging in their own literature review regarding an area of need within STEM Education. The aim of the literature review is to ground students in the literature and help students identify lines of inquiry to enact within their own communities through action

research (Considerations 2 & 7). All areas of research will be approved by the instructor prior to beginning their formal literature reviews, must be grounded in the STEM methodological approaches discussed in the course, and must address disparities regarding social justice implications (Considerations 7 & 9). All literature reviews must identify areas of additional research where they can begin to develop a plan for their action research or build upon current findings.

In addition to the literature review, students engage in a reflective critical analysis/ critiques of current STEM Education studies. Students seek to identify strengths and weaknesses in the methodology of the studies, as well as identify disparities, level of generalizability, barriers, and issues of equity within the studies (Considerations 3 & 7). The aim of this work is to help students identify strong methods, as well as learn to look at the literature with a critical lens and carry these skills into their future research. As students build their foundational knowledge in current practices and research across STEM Education, students will design and lead a mini-seminar based on at least two key articles from the course readings and at least five additional articles related to their topic, their plans regarding future studies, and issues of equity must be addressed (Considerations 1 & 9).

ACTIVISM IN MATHEMATICS EDUCATION

Advanced Readings in Mathematics Education is another course in our EdD STEM Program. This course introduces students to a broad survey of research in mathematics education. As part of the course, we embed readings and an assignment that focus on helping them think about social activism in mathematics education with their work as STEM education leaders (Consideration 1 & 6).

Readings

Key readings are included in the course to help students think about mathematics education from the perspective of activism and what it may look like to be change agents in their local educational communities and beyond (Consideration 2). For example, students read Chapter 1 “Algebra and Civil Rights?” from *Radical Equations: Math Literacy and Civil Rights* (Moses & Cobb, 2002). For many students, this reading is the first time they have thought about mathematics as a non-neutral subject that can be political in nature and can be used to help all students achieve more. Moses and Cobb (2002) offer the proposition that mathematics, in their text specifically algebra, is a civil rights issue. They explain that much like literacy, numeracy (i.e., the ability to understand and work with numbers) should be a skill afforded to all people. In our current society, people who cannot read often do not share that deficiency with others as it is shameful - sadly because they feel shameful for not being able to read but in truth, it is shameful to us as a society that we have denied them the opportunity to learn to read. In contrast, many in our society are not ashamed to say, “I can’t do math” - this should not be the case. Individuals should not be ashamed of *themselves* for not being able to “do math,” but we as a society should be ashamed that we have allowed individuals to progress through our educational system without the same right to be numerate, as they have to be literate (Considerations 1 & 9).

We read additional book chapters and articles from a variety of texts that focus on issues of equity, access, and power when thinking about social activism in mathematics education. For example, we

read Part 1 of the book, *The Impact of Identity in K-8 Mathematics: Rethinking Equity-Based Practices* (Aguirre, Mayfield-Ingram, & Martin, 2013). Titled “Rethinking Mathematics Learning, Identity, and Equity,” this section includes a discussion about what mathematics is taught in schools, for whom it is taught, and why it is taught. It further discusses ideas of identity and agency in mathematics and important concepts teachers need to understand to support student learning with regard to identity and agency. Finally, it unpacks how teacher identities are shaped and the importance of knowing yourself and your own biases when teaching mathematics to students (Considerations 12). Another article example includes “Engaging Teachers in the Powerful Combination of Mathematical Modeling and Social Justice: The Flint Water Task” (Aguirre et al., 2019). With a focus on the long struggle for clean water in Flint, Michigan, this article focuses on the implementation of a mathematical model task with teachers focused on that crisis. Findings from this study indicate that teachers can engage in both mathematical modeling tasks and social justice issues concurrently. This piece helps our students think about concrete ways to imbed social activism in the teaching of mathematics (Consideration 2 & 12).

One final example of a resource shared with students is *NCTM Advocacy Toolkit* (NCTM, 2008). The National Council of Teachers of Mathematics (NCTM) is “the world’s largest mathematics education organization” with a mission statement indicating it “advocates for high-quality mathematics teaching and learning for each and every student” (National Council of Teachers of Mathematics, n.d.). In 2008, they created an advocacy toolkit, as well as an advocacy section of their website, to help members advocate for mathematics education policy making (Krehbiel, 2008). This toolkit provides students with concrete examples and information to talk with policymakers about mathematics education for all students (Consideration 1 & 2).

Lastly, students also are encouraged to seek out additional articles to offer examples of socially responsive mathematics education. For example, some journals that offer such articles include the *Journal of Urban Mathematics Education*, *Journal of Research in Rural Education*, *The Rural Educator* and *Journal of Mathematics and Culture*.

Assignment

One assignment students complete in this course is to develop a lesson similar to the Flint Water Task exercise shared in Aguirre et al., (2019). Students are encouraged to choose a social issue that is of interest to them and the students they teach. Then, they research the issue using primary sources, when available. They then create a lesson to emphasize mathematics standards for their grade band and state that will illicit student discussion around the social issue (Consideration 1, 2 & 12).

To offer additional examples of possible intersections of mathematics problem solving and social justice, students can review mathematics textbooks as well as online resources. Students sometimes find word problems in traditional textbooks that have sound mathematical foundations that they can modify based on a social issue of which they and their students are interested. Students also sometimes find ideas from reviewing local newspapers or historical documents that they can then use to emphasize the desired mathematical content.

Three additional books also offer examples of how to encourage socially active mathematics lessons: *Rethinking*



Mathematics: Teaching Social Justice by the Numbers (Gutstein & Peterson, 2013), *Teaching Mathematics for Social Justice* (Wager et al., 2012), and *High School Mathematics Lessons to Explore, Understand, and Respond to Social Injustice* (Berry et al., 2020). The authors of the last book recently shared their experiences of compiling a book with such a variety of mathematics content and socially responsive lessons in a podcast that offers students additional insight into authoring such tasks (Amidon, 2020). In Berry et al., (2020), teachers offer examples of their socially conscious lessons. Some example lessons include looking at the statistical content associated with the census and how that data is collected, the geometry of gerrymandering, and the algebra and functions of fair living wages. From these examples, students see a variety of methods and ways to incorporate social activism in mathematics lessons (Considerations 1, 2 & 12).

ACTIVISM IN ENGINEERING EDUCATION

Principles of Engineering in STEM Education is another course in our EdD STEM Program. This course introduces students to a broad survey of research in engineering education. Readings and assignments are incorporated in the course to help students think about being socially conscious in engineering education as a STEM educator.

Readings

Given that engineering education is a new addition to K-12 schooling, at least in a systematic way, more resources concerning socially responsive engineering practices are currently found at the collegiate level. Although that makes it more challenging to find K-12 focused resources, we can encourage our students to fill the literature gap with their work and research (Considerations 3, 5 & 7). For example, a recent call from the *Journal of Pre-College Engineering Education Research (J-PEER)* is seeking manuscripts addressing the focus on asset-based engineering education (Martin & Wendell, 2020).

Students in this course read about issues of access, equity, and power in engineering such as asset-based engineering education, meaning “students’ existing assets should be taken as epistemologically primary, so that education is designed first around students’ assets, and conceptions of engineering are interrogated and reimaged as needed” (Martin & Wendell, 2020, p. 1). These readings are designed to help students think about opportunities for social activism within STEM engineering practices. One such project promoting asset-based engineering education that students learn about is the Asset-based Practices in Engineering Design (APRENDE) project. This particular project focuses on helping middle school students and their teachers emphasize funds of knowledge of Latinx students and English Language Learners to impact student interest in engineering practices (Mejia et al., 2019). Learning about asset-based engineering education and this project offers students an example of current work happening in the area of promoting engineering education for all students (Consideration 9).

Students also read Chapter 11, “Equity and Diversity in Science and Engineering Education” in *A Framework for K-12 Science Education* (National Research Council, 2012). This chapter begins with defining equity and continues by helping the reader reflect on possible sources of inequity, ponder what inclusive science and engineering instruction looks like, value student culture and

funds of knowledge – much like the work of Mejia et al. (2019), and emphasize the importance of student prior interest and identity. This chapter helps students begin to position themselves as students of their students when they approach engineering practices in STEM education. Like asset-based engineering practices, *students of their students* means teachers must learn what talents and strengths their students already possess and integrate those assets within the engineering content. What do they need to know about their students and their interest and understanding of engineering as they begin to work with them as STEM learners? (Consideration 1)

Students further consider how they can develop as socially conscious engineering educators in STEM by reading two additional *J-PEER* articles: “Capturing Children with Autism’s Engagement in Engineering Practices: A Focus on Problem Scoping” (Ehsan & Cardella, 2020) and “Who Is Welcome Here? A Culturally Responsive Content Analysis of Makerspace Websites” (Kye, 2020). Ehsan and Cardella (2020) spoke to the strengths of children with autism in engaging in engineering practices. Kye (2020) discussed the importance of grounding the work of makerspace work (Nation of Makers, n.d.) and websites in culturally responsive pedagogy. Also as noted in Mejia et al. (2019) and National Research Council (2012), these articles speak to exploiting the gifts, strengths, and expertise within students to engage them in the principles of engineering. The authors and those they study in these texts highlights the work our EdD candidates can emulate to become activists and change agents within their local educational communities and beyond (Consideration 1, 2, 3, 4, & 12).

Students also read Part I, “Service-Learning in Engineering Education,” in *Projects That Matter: Concepts and Models for Service-Learning in Engineering* (Tsang & Zlotkowski, 2007). With Part I, students read about community-based learning and professional activism. Though geared more for university engineering faculty, the concepts of infusing service learning into engineering classes such that students develop a socially responsive approach to engineering helps students see how they can use what they are learning in their classes to address community needs. This text offers students additional concrete examples of how they can integrate social responsiveness with content learning (Consideration 2, 6, & 12).

Four final examples of resources shared with our students are the “Diversity, Equity, and Inclusion” website at Colorado State University (n.d.), the “PEER & WISE” website at Clemson University (n.d.), “Engineering Inclusion” (n.d.), and the “American Society for Engineering Education” home page at the American Society for Engineering Education (ASEE) (n.d.). Each of these websites offers information about equity and access to students that offers examples of social activism in engineering education. For example, the PEER (Programs for Educational Enrichment and Recruitment) and WISE (Women in Science and Engineering) programs at Clemson University offer concrete examples of socially responsive programs working to increase the involvement of underrepresented populations in the sciences and engineering (Consideration 1, 6, & 9).

Assignment

When students take the Principles of Engineering in STEM Education course, they have already completed the Advanced Readings in Mathematics Education course. Therefore, they have all reviewed the *NCTM Advocacy Toolkit* (National Council of Teachers of Mathematics, 2008). In this course, one assignment is to develop

and share an Engineering in STEM Education (ESTEME) Advocacy Toolkit with a specific focus on parents (Consideration 2). Whereas the *NCTM Advocacy Toolkit* is designed more for political advocacy, this ESTEME Advocacy Toolkit is required to have a focus on parents – how can you help parents better understand what ESTEME looks like and how all children gain access to ESTEME. To complete this assignment, students research the “Access, Diversity, and Inclusion” and “Advocacy and Public Policy” sections of the ASEE website (n.d.). They interview a small sub-set of parents from underrepresented populations in STEM to learn more about what they already know about ESTEME and what they have questions about or need in terms of guidance (Consideration 2 & 12). Once they assemble the ESTEME Advocacy Toolkit, they share the final draft with at least one parent to gather feedback and if possible, use one or two resources created from their Toolkit to help the children learn more about ESTEME. The goal of this project is to support students in creating a living document that can be implemented to enact change. Students can then further distribute their ESTEME Advocacy Toolkit to additional parents or use this template to create additional STEM Advocacy Toolkits as they develop as social activists in STEM education.

CONCLUSION

Looking across the different coursework and experiences within our STEM EdD in reference to the 12 considerations for implementing activism within EdD programs, our program prepares graduates with strong practitioner research skills, a strong focus on improving their local community, and a strong social justice framework. Through action research coursework, EdD students are mentored through research methodologies that allow them to solve important practitioner-based problems of practice with a focus on equity and social justice. Through the STEM-focused education research courses (one for each discipline), students gain a strong understanding of current STEM education literature and how this literature can be translated into educational experiences that value all students and encourage a diverse group of future STEM professionals. The STEM research knowledge provides direction for EdD students to ask questions, create learning opportunities, or develop practitioner research methods that address the equity and social justice issues in their communities. The PBL courses take the learning experiences and social justice work directly to K-12 students. As the EdD students implement their created PBL units, K-12 students learn STEM content knowledge and connect with STEM career professionals in order to address local issues. Thus, the program expands the social justice efforts beyond the EdD students to impact a larger community. The EdD students are empowered as STEM activists as they are supported through the various program components and experiences.

The courses we have highlighted above represent one subset of the coursework in our program. As we continue to develop courses and redevelop existing courses, it is our hope that we will find novel and STEM-specific ways to address each of the considerations for supporting EdD activism. While we recognize our STEM EdD program is still in its first year, we draw on the experiences of faculty from two of the other EdD program concentrations that have been in existence in our college for many years. We further recognize the long standing and important role of the professional fields associated with STEM (Science, Technology, Engineering, and Mathematics) and their past and future

contributions to the work to resolve issues of social justice present in our society. It is our hope that the development and refinement of this program and its focus on equity and activism in STEM education will continue to contribute to the tradition of positive improvements provided by STEM related fields in the lives of American and global citizens alike.

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