Affecting Children's Attitudes Toward STEM

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Abstract

Elementary teachers play a vital role in encouraging and building confidence among young learners related to science, technology, engineering, and mathematics, as well as confidence in their abilities to solve problems creatively. Thus, it is necessary to teach STEM and prepare elementary teachers to deliver engaging project-based STEM during the formative years in elementary school, prior to students forming lifelong attitudes about the role that STEM might or might not play in their future academic and professional endeavors. This pilot study research aimed to clarify the role that project-based STEM could play in the elementary grades, model project-based learning for selected elementary teachers, and measure elementary students' change in perceptions about the STEM disciplines as a result of participating in the research. A questionnaire to assess students' perceptions of STEM and its role in their lives was implemented. From this empirical study, obstacles to the awareness of STEM through elementary education are discussed. The analysis of the results of the questionnaire implies that the inclusion of project-based learning and integrated STEM lessons could positively influence student perceptions early in the formal educational timeline leading to sustained interest.

Keywords*:* Elementary STEM, Project-based STEM, Elementary STEM attitudes, Student engagement, STEM pedagogy, Elementary STEM perceptions, Integrated STEM, STEM interventions

The acronym STEM (science, technology, engineering, and math) has become a well-worn descriptor among classroom educators for advancing science, technology, and math learning as well as an instructional strategy implemented to provide a foundation and motivation for students to pursue STEM focused careers (Becker & Park, 2011). The United States, as well as other nations, has been focused on ensuring that we have a sufficient labor supply for the projected growth and to serve the needs of our future economies. The most chronic economic shortage areas require individuals to have a strong background in STEM education and related technical skills to promote competitive economies (Caprile et al., 2015; Vilorio, 2014). Subsequently, U.S. policy makers and political leaders have placed the responsibility for preparing American citizens to accept such new jobs on the PK-12 public school system. Within the elementary grades, science, technology, and engineering have not historically held an obvious place within the curriculum. As a result, the content from these subjects has not been introduced to most American students during these important developmentally critical years (Daugherty, 2009). To address this new demand for increased student exposure to STEM, educational leaders have been tasked with the goal of vastly increasing the treatment of STEM content and 21st century skills within the PK-12 educational system (Owens et al., 2012; Thomasian, 2011).

In the endeavor to raise STEM interest, research has suggested that the best time for students to create a connection, awareness, and interest in STEM is before post-secondary and preferably during elementary school years (Russell et al., 2007). While a few elementary schools have begun to address some aspects of science in the elementary school, content from the fields of technology and engineering are rarely included in the curriculum. This results in elementary students not being exposed to concepts like design, problem solving, invention, and creative thought (Catterall, 2012). The goal of STEM programs within the elementary grades is to attract and maintain student interest in STEM subjects while increasing student performance within those subjects—especially with science and math content (Havice, 2015).

Best Practices for Elementary STEM

Numerous researchers have expressed widespread agreement on several best practices with regard to teaching integrated STEM content; these practices involve a challenge-based learning curriculum such as problem-based and project-based learning, cooperative learning, integrated disciplinary STEM content, and a design-based curriculum, i.e., materials and lessons that connect to the real world and are relevant to the student's interest and needs (Katzenmeyer & Lawrenz, 2006; Smith et al., 2009). Some research also suggests that primary students are more willing to participate in and remain engaged in learning STEM content when they have a positive connection to the content and experience some level of success in applying the STEM content (Capobianco et al., 2015). These crucial experiences are most commonly created when students are engaged in thought-provoking challenges and learning activities that they see as relevant to their current world and environment (Ainley & Ainley, 2011). While engaging students through meaningful and relevant instruction is not a new pedagogical concept it is important to remember that it is the heartbeat of STEM teaching and learning as it provides the connection to the real world (Margot & Kettler, 2019).

While it is important, increased math and science content knowledge is not the only factor that students need to be successful in STEM; they also need to know how to work and communicate effectively with others inside and outside their immediate area of influence. It is a reliance on 21st Century skills such as cooperative learning, problem solving, and critical thinking that seem to be driving some of the most effective STEM education programs (Brusic & Shearer, 2014). Macpherson (2008) defines cooperative learning within the classroom as an interaction between students in which inquiry and communication come together to increase mutual understanding. He asserts that the difference between individualized instruction and cooperative learning strategies makes a substantial difference in learning outcomes. In traditional small or individualized instructional groups, there is no structured interdependence, individual accountability, or active communication between learners. This demands that the teacher incorporate cooperative learning methodologies that require students to think critically, cultivate a deeper understanding, defend their positions, and practice social interaction skills to successfully promote proposed solutions and communicate ideas that may solve the given problem.

Children do not come by these skills naturally, and a cooperative learning classroom can create a safe environment for novice students to practice using cooperative learning strategies, build confidence in themselves and their abilities, and exercise social interaction practices, which are critical within the STEM fields (Yoruk, 2016). Furthermore, cooperative learning allows educators to put the emphasis back on the student. This may allow the student to acknowledge and identify helpful group behaviors, promote effective teamwork, and force the creation of group and individual accountability toward an end goal of team success (Sahin et al., 2014). Successful outcomes with cooperative learning may be attributed to the promotion of continuous team discussion, debate, and clarification that is critical for successful team problem solving. Ultimately, cooperative learning creates a student-centered learning environment that allows students to engage with new content while resolving conflicts by using research and acquired knowledge as the foundation to negotiate solutions (Cohen, 1994).

Integrated STEM lessons or content-rich STEM challenges that arise from the student's perspective seem to be most effective in attracting and maintaining student engagement. In a study conducted by Habashi et al. (2008), the researchers found that teachers were more effective at directing elementary students' interest toward integrated STEM content when the students' personal interests were explored through tangible objects rather than abstract thoughts or feelings. Similarly, DeFraine et al. (2014) noted that student success occurs when the teacher delivers a content-rich learning challenge that integrates STEM content through a hands-on project or challenge. Additionally, DeFraine et al. (2014) noted that the hands-on challenges should demonstrate how the applied content is not only applicable in the real world, but also how it relates to the students and their community.

Supporting this notion, Goeke and Ciotoli (2014) implied that students experienced increased levels of motivation in classroom learning when they were able to recognize a personal connection from their integrated STEM projects to the real world. These students also exhibited an increased level of engagement and became more engrossed in the exploration of the content as well as the life application of what they are learning when the content was delivered through an authentic problem with which they could relate. These methods are recognized for creating realistic learning opportunities for students that exhibit innate problem-solving inclinations, embrace creativity, view hands-on projects and challenges as fun learning experiences, while also being open to learning new content that they may have never received in a traditional classroom or individualized learning experiences previously (Allendoerfer et al., 2014).

The Role of Bias and Attitude on Learning

In order to implement best practices successfully in the primary classroom, the teacher must not only understand the student but also be aware of gender bias and student dispositions toward STEM. One critical element that must be considered to expand student engagement and interest in STEM subjects is the student's current disposition for learning. Several researchers (DeJarnette, 2012; Wigfield, 2010) implied that elementary students develop beliefs and dispositional attitudes toward science and math content by the end of the fourth grade. Further evidence suggests that almost half of students decide to avoid continued or advanced STEM subject matter learning before reaching the eighth grade. In a study conducted by Archer et al. (2012), the researchers discovered that once a student develops a negative disposition toward STEM subjects, that attitude will influence decisions throughout his/her educational experience and ultimately influence their career choices. Therefore, efforts must be taken to develop curricular programs and instructional approaches that reach these impressionable students while they are still open to the possibility of a continued acceptance of, and engagement in, STEM subject matter learning and investigation (Agranovich & Assaraf, 2013).

Another factor that may influence student engagement in STEM is perceived or real gender bias. Several research studies have suggested that young girls rely heavily on role models when developing their interests and future career aspirations (Toma & Greca, 2018; Tyler-Wood et al., 2018). Gender bias has been known to have a stronger emphasis on decisions than the student's achievements, especially in mathematics and science (Catsambis, 1995; Mattern & Schau, 2002). A student's gender can also affect how they approach learning and demonstrate an understanding about STEM subjects (Murphy & Elwood, 1998). Masculine and feminine societal expectations can play a role in how students respond to and participate in certain subjects. In a study conducted by Virtanen et al., (2015) it was found that girls were more likely to concentrate on the environment and making decorative projects, where boys were more interested in using tools. This study also noted that boys were more confident in their ability to learn new things in comparison to their female peers who required encouragement from the teacher to continue. In turn, the teacher's misconceptions and lack of awareness of gender bias, or the perception of bias, can also influence the way those students, especially girls, approach STEM subject learning. Supporting these research findings, Berekashvilli (2012) found that female students' skills and talents were often underrepresented and unpraised within the classroom. Berekashvilli (2012) noted that teacher's expectations were unknowingly lowered for female student achievement in math and science but often raised in subjects like English and reading. The author noted that this was often done without malice but rather happened without forethought. The implications of these research studies emphasize the vital need for elementary teachers to engage all students, especially females, for these students to build the confidence needed to continue their pursuit of STEM learning and achievement.

Teaching and Instructional Strategies in the Elementary Classroom

The last twenty years have marked a steep increase in the use of national and state standards or frameworks to guide instructional practices and curriculum development among public schools in the United States (Shepard, 2009). There is a consensus among educators for increased STEM content and for the application of 21^{st} Century Learning Skills to be included as a part of the daily classroom curriculum (Lamb et al., 2015; Darling-Hammond, 2019). However, Judson (2012) suggests that most elementary teachers focus their curriculum primarily on literacy and the content identified on the yearly benchmark tests that include scant science, technology, or engineering content or learning experiences. Archer et al. (2012) found that in elementary classrooms the introduction of science as a content subject area does not often occur until after the fourth grade. Unfortunately, this occurs after many students have already begun to form decisions about their interests and future in STEM. Our public schools have responded by adopting and utilizing national standards like The Standards for Technological Literacy (STL) standards, the Common Core State Standards (CCSS), and the Next Generation Science Standards (NGSS) as guideposts to validate curricular offerings. Among other things, these learning standards were all designed to promote college and career readiness by using integrated content learning during the early grades (Stage et al., 2013). For example, the NGSS standards impact student learning and the development of 21st Century skills through the inclusion of engineering practices and design-to-demonstrate core concepts, such as problem solving, multi-discipline learning, and the use of models and hands-on projects (Cardno, 2013).

These standards call on the elementary teacher to deliver the content standards by developing STEM or integrated lessons and challenge-based learning experiences that draw upon the connections between the content of these four fields of study and other disciplines (Adams et al., 2014). Ideally, students who complete such learning experiences will be able to expand on multiple subject matter knowledge areas to solve problems and design creative solutions to learning challenges in collaborative learning environments (Adams et al., 2014). Students engaged in learning driven by integrated content standards should experience a level of learning that more readily transfers to the workplace and society in the 21st century (Darling-Hammond, 2019).

In a recent study examining the teaching methods for STEM content, Capobianco and Rupp (2014) affirm that the elementary teacher’s ability to develop integrated STEM lessons or real-world design challenges that draw connections between essential content from all STEM subject matter, while making connections to students’ personal interests was sorely needed if we are to make an impact on the student for continued pursuit of STEM learning in the future. While most elementary educators would likely agree with that assertion, it is not uncommon for elementary teachers to feel apprehensive about teaching integrated STEM lessons in their classrooms for a host of reasons (Goodnough et al., 2014). Notably, many elementary educators express a sense of apprehension and fear of STEM because they have not had deep educational experiences or training in the STEM content areas.

Rittmayer and Beier (2008) noted that teaching integrated STEM content in the elementary school might be hampered by the teachers’ lack of confidence and content knowledge as well as general discomfort with ill-structured, inquiry-based, or problem-based learning methodologies. Supporting this assertion, Boulay and Van Raalte (2013) found that teachers were lacking the ability and resources to create real-world applications of STEM content for their students. Essentially, elementary teachers need to be prepared to design and implement ill-structured theme-based design problems that cause elementary students to solve engaging problems directly related to STEM or other content standards (Margot & Kettler, 2019). Teo and Ke (2014) note that the ability to model appropriate best practices for teaching and implementing new integrated STEM programs within the elementary classroom will be essential if wholesale changes in curricular offerings are to be expected. Without modeling support and direction, elementary teachers will likely be unsuccessful in their efforts to lead integrated STEM in their classrooms--leading to frustration for the teacher and the students (Teo and Ke, 2014).

Epstein (2011) proposed that there is an urgent need to develop elementary teacher education programs and projects to prepare highly skilled STEM teachers who have the ability and confidence to provide engaging integrated lessons that deliver core content from the STEM disciplines in a realistic manner. Given the fact that most existing and future elementary grade teachers are not likely to have extensive content knowledge or practical experience in the STEM disciplines or extensive experience developing STEM lessons and activities, modeling best practices of exemplary STEM programs might be the most appropriate avenue toward comprehensive change. Pinnell et al., (2013) suggested that for elementary teachers to fully understand and implement integrated STEM lessons and projects with real-world applications, they will need to have appropriate practices modeled for them. This modeling could be carefully crafted to illustrate methods by which current curricular practices could be modified to increase the treatment of STEM in the elementary classroom. Subsequently, the following research was conducted to serve as a model illustrating how STEM best practices directly relate to the learning and engagement of elementary students.

Methodology

This pilot research study investigated how integrated STEM content, when coupled with cooperative learning involving problem-/project-based learning, can influence change, increase student interest, and improve student performance in one local elementary school in the United States Mid-South region. This project served as the first time that cooperative learning integrated with problem-/project-based teaching had occurred within this elementary school. The research was implemented to introduce second-grade students to project-based integrated STEM content lessons, while simultaneously modeling best practices in problem-/project-based teaching for grade level teachers. Throughout the school year, numerous project-based integrated STEM lessons were developed and delivered that targeted specific content from second grade STEM standards identified in CCSS, NGSS, and STL. These lessons delivered content utilizing real-world contexts while providing hands-on learning and 21st century skills, including the use of problem-solving techniques and communication systems. Using data collected from two different second grade classrooms, the study attempted to determine whether the integrated STEM lessons impacted students' engagement among the STEM disciplines and their efficacy related to the STEM fields, as well as their career aspirations within STEM fields.

This study was coordinated through the University of Arkansas's Education Renewal Zone. The Arkansas Education Renewal Zone was established in 2003 with the overarching goal to address the current needs of community schools by providing resources, strategies, and tools to improve school performance and academic achievement for all students. This Education

Renewal Zone program was designed to connect a content expert such as a professor, staff member, or doctoral student specializing in a specific area, with elementary teachers in local partner school classrooms several times throughout the school year. The Education Renewal Zone sent an email request for participation to area classroom teachers as well as to university faculty, staff, and graduate students across campus. The Education Renewal Zone matched the interested participants based on expertise and classroom teacher needs. The content experts and the elementary teachers were then introduced to each other at a banquet where they met, planned, and coordinated their schedules for the semester.

This study was conducted in a second grade classroom within one of the elementary schools participating in the Education Renewal Zones program. The classroom teacher was primarily concerned with her students' reading scores, particularly inferential reading as the majority of the students in the class had scored below benchmark expectations on a recent state standardized test. The researcher used inferential reading as a catalyst to introduce the integrated STEM content. The researcher developed curriculum materials for the research that both delivered STEM content in a real-world context while providing hands-on learning and 21st century learning skills including problem-solving experiences, reading in context, and communicating their designs using real data. In addition, the curriculum developed for the project included a sense of relevancy and excitement to ensure that the participating students were engaged in not just the project but also in the associated learning content.

Three interventions were developed for this study. They consisted of three one-hour integrated STEM lessons delivered to the participating students by the researcher. The first intervention lesson included a design problem that asked students to work in teams to modify a shelter to keep the popular Olaf character from the Disney movie *Frozen* cold enough to visit their school. This lesson targeted three main learning goals, which included the design process, understanding of water properties, and the use of measurement. The students were given a themed newsletter, which directed them to explore different heat stations and materials. The students used the newsletter to track observational data from each station. The researcher stressed the importance of documenting key details and discussed why this was important and how researchers in the real world also had to document data for use in other studies and applications. Once completed, the students were assigned to small table groups and were required to complete an engineering design journal. The journal required students to defend and explain their contributions and rationale using data from the previous activity before building their project. The students were provided with an assessment rubric and were assessed, not only on the overall design, but also on their understanding of the content, reading, and writing. During the conclusion of the lesson, students were asked to share their design and experience from the project as a method for assessing their ability to communicate and share ideas.

The second intervention lesson asked students to work as electrical engineers. The students in this lesson were required to complete a simple electrical circuit to illuminate Rudolph's nose and guide Santa's sleigh. In order to complete this project successfully, the students were required to demonstrate understanding of science through energy transfer, technology, and engineering via energy forms, troubleshooting, and mathematical fractions. The students were provided with content, which was directly applied to the project. The students were provided with an assessment rubric, and were assessed not only on the overall design, but also on their understanding of the content, reading, and writing. During the conclusion of the lesson, students were asked to share their design and experience from the project as a method for assessing their ability to communicate and share their ideas. This was used as a formative assessment for student learning and understanding of core learning concepts.

The third intervention lesson required students to work in small table groups as mechanical engineers to build a fishing pole that could hold the most weight. The narrative text *Jangles* was used in this lesson to engage students and draw them into the project. The students were required to complete an engineering journal, including rationales for their designs and explanations for any modifications to their designed fishing pole. The students demonstrated understanding of science content through their explanations and project designs to minimize the force and weight of the fishing pole, technology, and engineering via their design journals and redesign of their projects, and mathematics through their calculations of the weight held on the balance scale. The students were provided with an assessment rubric and were assessed, not only on the overall design, but also on their understanding of the content, reading, and writing. At the completion of the lesson, students were asked to share their design and experience from the project as a method for assessing their ability to communicate.

The researcher's participation in this project allowed her to model and share exemplary practices for integrated STEM in the elementary classroom. This was done through a cooperative learning environment, allowing students to navigate the learning within each lesson, and ensuring the targeted learning concepts were met for each student.

Preliminary research data were collected using a student interest survey. The student interest survey was completed by students participating in the research as well as students in another second-grade classroom within the same school (control group) that did not receive the treatment. The demographics for the two involved classrooms are listed below in Table 1. The data for this study were analyzed using an independent t-test as well as Cohen's d to measure the effect size.

Table 1

Classroom Demographics

Control Group	Treatment Group
N=18	N=20
Boys = 8 Girls = 10	Boys = 12 Girls = 8

Findings

Although the research served as a pilot-test for a larger research project, the initial findings reveal that the integrated STEM design challenges delivered through the three interventions did influence the student's current interest in STEM subjects as well as their career aspirations within STEM fields after treatment in comparison to the control group that did not participate in the research treatment. The data showed a significant difference for the students who completed the intervention as indicated below in Table 2.

Table 2

Comparison of Student's Attitudes toward STEM after Experiment

					95% CI		
Variable	*t*	*df*	*p*	*MD*	*LL*	*UL*	*d*
I am good at science.	2.25	36	.03	-.46	-.88	-.05	.72
I am good at math.	2.43	36	.02	-.54	-.99	-.09	.78
I am good at engineering.	6.41	31.6	.000	-1.08	-1.43	-.74	2.05
I like learning how things work.	3.66	36	.001	-.63	-.98	-.28	1.18
I am creative.	.27	36	.79	-.05	-.42	.32	.08
I like solving problems that I don't know the answer to.	7.56	34.14	.000	-1.28	-1.62	-.93	2.43
I like to build and make things.	4.77	36	.000	-.94	-1.34	-.54	1.55
I would like to be a scientist.	1.74	36	.09	-.37	-.81	.07	.56
I would like to be an engineer.	9.28	25.28	.000	-1.34	-1.64	-1.05	2.03
I would like a job where I could invent things.	3.55	36	.001	-.68	-1.06	-.29	1.15
I would like to design machines that help people.	3.78	36	.000	-.70	-1.08	-.32	1.23
Scientists help make people's lives better	5.75	36	.000	-1.04	-1.41	-.68	1.86
Engineers help make people's lives better.	3.10	36	.004	-.54	-.89	-.19	1
I know what scientists do for their jobs.	2.75	36	.01	-.48	-.84	-.13	.9
I know what engineers do for their jobs.	1.84	36	.07	-.32	-.68	.03	.6

As indicated in Table 2 the data analysis illustrates that students in the experimental group held significantly higher self-perceptions of “being good at science” t(36)=2.25, p=.03, d=.72; “being good at math” t(36)=2.43, p=.02, d=.78; and “being good at engineering” t(31.6)=6.41, p<.001, d=2.05 than the students in the control group.

Similarly, students in the experimental group presented significantly different results in their interest related to STEM in the following categories of “learning how things work” t(36)=3.66, p=.001, d=1.18; “solving problems that are not familiar” t(34)=7.56, p<.001, d=2.43; and “building and making things” t(36)=4.77, p<.001, d=1.55 than the students in the control group.

Students in the experimental group also presented significantly different results in their interest to pursue STEM careers in the following categories of “career aspirations in engineering” t(25.28)=9.28, p<.001, d=2.03; “career aspirations for inventing” t(36)=3.55, p=.001, d=1.15; and “career aspirations for designing machines to help people” t(36)=3.78, p=<.001, d=1.23 than the students in the control group.

Students in the experimental group also showed differences in their beliefs and understanding in these STEM areas: “belief that scientists make people’s lives better” t(36)=5.75, p<.001, d=1.86; “belief that engineers make people’s lives better” t(36)=3.10, p=.004, d=1; and “self-knowledge of what a scientist does for their job” t(36)=2.75, p=.01, d=.9 than their grade-level peers in the control group.

While this pilot study was designed to focus on the impact on the students, the impact of learning for the teacher is also worth noting. The classroom teacher was always present in the classroom during the research interventions. During the first two lessons, she mainly sat in the back of her classroom and observed. After the second lesson, she asked more questions about the curriculum development piece. Her questions focused on how ideas for the lessons were created, how to implement the priority standards for grade-level learning, and on developing assessments. During the third intervention, the teacher took a much more active role in the students’ learning, design process, and using observational data for formative assessment. Following the three interventions, the classroom teacher noted that the project helped her develop the confidence that led her to continue developing and teaching additional integrated STEM lessons throughout the school year. This teacher also commented on how anxious she would be when the researcher asked certain students to defend an idea or decide as a group which design they would choose when their ideas conflicted with each other. She said that watching her students defend their work as well as have their peers support them in that process was something she intended to encourage moving forward.

During the third intervention when it came time to test their design modifications, the students became very excited and loud, but also actively engaged. The other grade level teachers, along with their school principal, observed the students testing their final product designs. The researcher asked the principal if she could stay for a few more minutes to listen to our discussion and lesson debriefing. The students were eager when we asked which group wanted to share what they learned, why it was important, and if they would want to pursue a career that involved this type of design and knowledge. These students were able to defend their ideas using their design journals to provide the necessary evidence to support their claims. The principal was impressed with the student responses to questioning and their perceived value of their own learning. This project helped to raise her expectations for student learning and engagement at the lower grade levels.

Conclusion

This pilot-test research suggests that teachers can influence STEM interest by ensuring that all students are routinely involved in problem solving, critical thinking, collaboration, planning, and communication. This can be accomplished by providing elementary-aged students with engaging, positive, and successful experiences within the STEM disciplines, thereby creating an environment where children yearn for more information, search for solutions to human problems, regularly blend disciplinary boundaries, willingly conduct research, seek answers, and continue learning well beyond the classroom. Delivering integrated STEM lessons in the elementary classroom is another step towards creating a more involved and more intellectually curious society and an insurance policy for the future of our nation.

STEM is increasingly important to our society and elementary teachers can affect student interest by engaging students in the study and application of these disciplines at an early age. By engaging students during the early years, educators can supply them with the tools necessary to keep them engaged throughout elementary, secondary, and postsecondary education. This will require classroom teachers to not only understand the learning standards but also to understand their significance within the students' interests and community. Teachers should also develop an enthusiasm for finding and exploiting the connections between disciplines, real-world applications, and centering their teaching on the students and their world. Educators must communicate information utilizing a variety of teaching methods that allow the students to explore, create, and learn concepts important to the world around them. Teachers must not only commit to teacher professional development but also have a willingness to develop and teach content in a manner that ensures that our students' environment connects with their learning. This process begins by preparing elementary teachers who are capable, comfortable, and enthusiastic about implementing integrated STEM education in the elementary classroom—this can best be accomplished by modeling best practices for those teachers.

(See author bios on the following page—Ed.)

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Michael K. Daugherty is a Distinguished Professor of STEM Education in the College of Education and Health Professions at the University of Arkansas in the United States. He earned a BS, MS, and EdD from Oklahoma State University. Dr. Daugherty speaks nationally and internationally on STEM education, project-based learning, technological literacy, standards, and curriculum development. He is the author of 26 books and book chapters, over 70 journal articles, and numerous curriculum sets. Michael has conducted more than 100 presentations and keynote addresses at state, national, and international conferences. He has been the recipient of numerous awards including the Technology Teacher Educator of the Year Award by the *American Council on Technology and Engineering Teacher Education,* the Award of Distinction by the *International Technology & Engineering Educators Association*, and most recently, the Mary Margaret Scobey Award by the Elementary STEM Council.

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