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ANALYSIS OF A STEM EDUCATION PROFESSIONAL DEVELOPMENT CONFERENCE FOR PRE-SERVICE EDUCATORS

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in partial fulfillment of the requirements for the degree
Doctor of Education with an emphasis in Educational Practice

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Abstract

Science, technology, engineering, and mathematics (STEM) disciplines are attracting increased attention in education. The iSTEM 2017 conference was a professional development program designed to acquaint pre-service teachers with interdisciplinary, research-based STEM instructional strategies that can transform traditional classroom instruction into dynamic learning environments.

The STEM Education Scholars (STEMES) is a Learning Community of Practice, housed in the College of Education, at a midsized mid-western public research university. The program of study focused on designing a professional development program for future Pre-K12 teachers. The iSTEM 2017 conference presented by the STEMES Community of Practice sought to inform pre-service teachers of STEM pedagogy, and focused on innovative classroom resources, hands-on learning and increasing content confidence when incorporating STEM into classroom instruction. iSTEM 2017 was held in February, 2017, and offered twenty refereed presentations and workshop sessions, a keynote address, and a closing session to over 200 pre-service teachers.

Conference participants chose sessions, participated in game-like experiences and shared their learning with each other as well as with conference organizers. Results from participant self-reported surveys were analyzed to measure the impact of the conference on improving participants' confidence in teaching STEM topics, and their attitudes about the instructional methods. These results were added to the conference proceedings, which also contain documentation of each iSTEM 2017 session. Findings suggest that the iSTEM 2017 conference had an overall positive impact on participants' familiarity with

STEM education, their belief in the importance of STEM education, and their confidence to integrate STEM education into future instructional practices.

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Chapter 1

Introduction

Purpose

"One of the things that I've been focused on as President is how we create an all-hands-on-deck approach to science, technology, engineering, and math… We need to make this a priority to train an army of new teachers in these subject areas, and to make sure that all of us as a country are lifting up these subjects for the respect that they deserve."

President Barack Obama
Third Annual White House Science Fair, April 2013

The national debate on the content and implications of educational standards in science and mathematics is fueled by studies highlighting an increasing deficiency in STEM skills in the workforce (Rothwell, 2014; Langdon, McKittrick, Beede, Khan, & Doms, 2011; National Science Board, 2015). These studies place increased pressure on schools and communities to focus more instruction on and to improve student achievement in science, technology, engineering, and mathematics (STEM). Those four core disciplines were deemed critical for innovation by legislators such as those in the STEM Education Caucus; by educator organizations, , including the STEM Education Coalition, the National Science Foundation, the National Science Teachers Association, and the National Council of Teachers of Mathematics; and industry leaders, including the US Department of Commerce and the Bill & Melinda Gates Foundation.

In 2001, Judith Ramalay, former director of the National Science Foundation's Education and Human Resources Division, first defined the curriculum relating to science, mathematics, engineering, and technology as STEM (Teaching Institute for Excellence in STEM, 2010). Dr. Ramalay summarized the need to group these four disciplines together. She connected science and mathematics knowledge as critical to a

basic understanding of the universe, while engineering and technology provide the tools for allowing people to interact with it.

Since 2001, STEM definitions have developed along varying paths, but generally include the interconnected relationship among the four disciplines. Zhou (2011) acknowledged the variation among STEM definitions and found that they generally fall into two categories: STEM education or STEM occupations. This subtle difference hinges on the perspective of the institution using the STEM acronym. Recommending a standard definition of STEM was not the goal of this dissertation. Rather, this dissertation celebrates the generally uncontested belief that students need to improve STEM skills not only to be qualified for better careers but also to develop essential 21st century skills that Zipkes (2016) identifies as communication, critical thinking, problem-solving, collaboration, and creativity.

As STEM-related jobs continue to multiply (US Department of Labor, 2017), so does the need for STEM-skilled students. However, the United States is graduating fewer students in STEM disciplines (Chen, 2013), leading to a workforce development crisis (US Department of Labor, 2015; US Department of Labor, 2017). This crisis must be resolved if the United States is to remain a leader in science and technology innovation in the 21st Century (Fingleton, 2013). In recognition of this critically important educational lag, the authors of this dissertation, known collectively as the STEM Educational Scholars (STEMES) cohort, designed a professional development conference. It was designed to inspire and help prepare pre-service teachers to integrate STEM education into their teaching practice. In time, that practice will bolster student interest and preparedness to pursue STEM degrees.

According to the US Department of Commerce (2011; 2017), STEM workers contribute a considerable global advantage to the United States in innovating, generating new ideas, forming new companies, promoting new directions for industry, and stimulating the economy. The Office of the Chief Economist (OCE) offered a 2017 update to the US Department of Commerce's report, "STEM: Good Jobs Now and for the Future," and claimed that employment opportunities in STEM occupations grew much faster than employment opportunities in non-STEM occupations over the last decade, 24.4 percent versus 4.0 percent, respectively. The updated report projects that STEM occupations will increase by 8.9 percent from 2014 to 2024, compared to 6.4 percent growth for non-STEM occupations. The Brookings Institute report "The Hidden STEM Economy" (Rothwell, 2013) confirmed the Commerce Department's findings and stated that nearly 26 million jobs account for 20 percent of all US jobs that require a high level of knowledge in at least one STEM field. Within each of the STEM fields, engineering is the most prominent STEM field encompassing 11 percent of all jobs, or roughly 13.5 million jobs that require high levels of engineering knowledge. Careers requiring high levels of knowledge in science account for 12 million jobs. Careers requiring high-level math and computer-related knowledge constitute fewer, but still millions of jobs, 7.5 and 5.4, respectively. Other careers require expertise in more than one STEM field.

With a growing demand for a highly-trained STEM workforce, wages are also increasing. Employees working in STEM fields earned 29% more than their non-STEM counterparts in 2015 (US Department of Commerce, 2011, 2017). In addition, among workers in similar positions, holding all other factors constant, those who have STEM degrees earn 12% more than those workers with non-STEM degrees. Despite claims that

the STEM workforce shortage is a myth based on how STEM jobs are defined (Teitelbaum, 2014; Cannady, Greenwald & Harris, 2014), these US Department of Commerce statistics reinforce reports that skilled STEM jobs are growing and in demand, especially within the technology sector (Vilorio, 2014; Change the Equation, 2014; Department of Education, 2015; Adecco, 2017).

Even though there are rapidly increasing employment opportunities for higher earning potential in STEM fields, particularly for those job-seekers with STEM degrees, the number of students selecting STEM fields as a major is in decline (Carnevale, Smith & Melton, 2011; Business Higher Education Forum, 2014). Interest in pursuing STEM among high school age teens is also in decline, and that suggests that the first step in developing a higher number of STEM-prepared workers is to bolster student interest in STEM fields (Junior Achievement, 2013).

Georgetown University's Center on Education and Workforce Report (Carnevale, Smith & Melton, 2011) offers insight into why students do not choose to pursue STEM degrees. The researchers conclude that earning potential is not a factor in degree choice as students may be disconnected from the labor market. Rather, they claim that information about STEM fields, perceptions about this kind of work, students' own personal hobbies, work interests, and work values are likely to be the most important reasons. The Business Higher Education Forum (BHEF) tied STEM work interest to the choice of STEM careers and recommended programs to help develop and maintain student interest in STEM. They claim that skill in STEM is not enough to keep them in the STEM pipeline leading to a career (2013). The BHEF report (2014) recommended

professional development programs for K12 teachers as a key component to increase student interest and preparedness.

To address what many term a STEM job crisis (National Science Board, 2015) and to bolster student interest, federal, state, and local governments offer multiple approaches to strengthen STEM education and attract students to pursue STEM fields. The Brookings Institute (2013) summarized federal government expenditures on STEM education programs in 2010 as presented in Table 1.

Table 1
2010 Federal Government Funding for STEM Education Programs by Primary Objective

	Approx. Amount (in Millions of Dollars)	Share of Total Expenditures (%)
Bachelor's degree or higher STEM education	$1,942	45
Training or sub-bachelor's level degree education (upper limit*)	$940	22
Education research and development	$519	12
Pre- and in-service educators	$312	7
Public learning	$296	7
Engagement of children	$162	4
Institutional capacity	$137	3
Total federal funding for STEM training or education	$4,308	

Table 1 shows that nearly half of the expenditures were allocated to scholarships and financial incentives for students to pursue higher education STEM degrees with additional funding available for vocational and community college certifications to

support STEM workers in the construction trades. The remaining funding was allocated to K12 and informal educational sites such as museums. The report references the Department of Education's "investing in innovation" 2013 grants, awarding $26 million of the total available $143 million to four projects aiming to boost K12 STEM education through interventions such as the curriculum-based intervention "Project Lead the Way" and an extracurricular intervention "Pathways to STEM" partnering K6-12 students with STEM professionals in weekly meetings and offering STEM summer camp experiences. The Brookings Institute (2013) concluded that programs designed to stimulate interest and inspire students to pursue STEM are currently difficult to evaluate, and stated that more data is needed.

Guided by the Obama Administration's determination to improve STEM education (Educate to Innovate, 2013), Missouri's Department of Elementary and Secondary Education (DESE) responded with an initiative to increase STEM opportunities across K-12 schools in Missouri (Change the Equation, 2012). DESE reports showed that content knowledge of teachers and teaching experience affect student performance (Vital Signs, 2012). A strong teacher workforce confident in STEM education, will strengthen the STEM talent pipeline in the United States (Moakler & Kim, 2014; Rogers, Winship, & Sun, 2015).

Armed by this national call for informed teachers and by Missouri's need for STEM educated students, the STEM Education Scholar (STEMES) cohort focused on strategies for helping future teachers more confidently incorporate STEM education lessons and innovative teaching practices. The resulting intervention, the iSTEM 2017 professional development conference, invited 250 pre-service teachers to participate in

carefully crafted experiences to inspire them to find connections within their own practice, and share the culminating efforts of three years of focused graduate work on STEM education.

The History of iSTEM 2017

In Fall 2015, each STEMES cohort member presented three "burning questions" to the cohort. The burning questions served as a starting point for discussions about STEM educational practice. From these questions, cohort members immersed themselves in research that addressed each topic. Each cohort member narrowed their scope and focused on one question on which to conduct research. The diverse topics were presented in a manner that conveyed a common message or theme in educational practice. Individual ideas were combined to create a coherent message.

The STEMES cohort was asked to imagine what a group dissertation in practice might look like if it included the burning questions from every member. Among those proposed ideas were a thematic book, one or more traditional dissertations, evaluations of school programs, creation of an integrated curriculum, the development of an after-school club, and a conference/workshop for educators. Cohort members presented their ideas for a dissertation product to the group and invited open dialogue about the potential impact the idea might have on STEM educators. The final decision to hold a conference was chosen after using a sophisticated point-based rubric that categorized each dissertation product by intended outcome in a double-blind peer review manner (see Appendix B for the decision matrix). Ultimately, the consensus was to host a STEM conference as a means of professional development for educators.

Teacher professional development (PD) can take many forms, categorized by Grimmett (2014) into three domains: professional knowledge, professional practice, and professional engagement. PD programs designed around developing professional knowledge focus on ways to help teachers understand more about their students and how they learn within the subject area they teach. PD programs focused on professional practice focus on how to implement teaching and learning environments, assess students, and craft constructive feedback. PD programs focused on professional engagement include those about professional learning and connecting in professional learning networks and communities. Whether the PD programs are professional learning communities, seminars, workshops, coaching or conferences, a program must be carefully designed and implemented within a professional development design framework (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). This framework begins with a commitment to the goals, standards, and vision for the program, taking into account the audience's knowledge, beliefs, and needs. Planning and implementing the program around the goals and needs of the audience requires more than touting the latest fad. Loucks-Horsely et al (2010) remind us that effective PD programs should seek to reach four interconnected outcomes: 1) enhance teachers' knowledge, 2) enhance quality teaching, 3) develop leadership capacity, and 4) build professional connections and opportunities to engage in continuous learning.

Fueled by recommendations from the Brookings Institute (2013), President Obama (2011), and other studies (Junior Achievement, 2013; Rogers, Winship, & Sun, 2015; Change the Equation, 2012), the STEM Educational Scholars community of practice cohort researched effective types of teacher professional development. The goal

was to determine if hands-on, minds-on experiences with practical applications in any discipline would be best received when participants could imagine using what they are learning, when they are learning it, and if they could identify and choose topics of interest that would enhance their professional development.

Designing a fun atmosphere surrounding the professional development offering was deemed to be important. Offering professional development as a conference allowed for all cohort members with their own varying backgrounds, research interests, and specializations, to develop and implement a diverse program and agenda about the complex topic of STEM educational practice.

The conference idea became more defined in spring 2016. Initially, the cohort hoped to design a conference for practicing teachers within the metropolitan area. However, due to numerous constraints on the originally intended audience, including competing time demands on teachers, a lack of incentive funds in regional school districts, and multiple professional development dates at odds at each school, the open conference idea was abandoned. Instead, attention was given to how a conference might serve the pre-service teacher population. With a new direction, one significant decision was to brand the conference to the new target audience by giving it a name that signified confidence and ownership of STEM education, hence the name, iSTEM 2017.

Sharing knowledge, experience, and excitement about STEM was the catalyst to create the iSTEM 2017 workshop for pre-service teachers. With an identified audience and conference title, a list of tasks and committees for the professional development conference was constructed. Cohort members chose to serve on committees based on their identified strengths and interests. Planning began immediately on iSTEM 2017, with

each person chairing at least one committee, while simultaneously being a member of other committees.

The STEMES Community of Practice focused their dissertation in practice on addressing content knowledge and pedagogical knowledge in STEM during the preparation of pre-service teachers. The goal was to help prepare teachers who are successful and confident in teaching the 4Cs: critical thinking, creativity, collaboration and communication, which are considered foundational for effective STEM education (Partnership for 21st Century Learning, 2015). The iSTEM 2017 professional development conference was designed to engage the pre-service teachers in hands-on workshops, to provide them experiences with integrating STEM lessons into their practice, and to present them with digital packets of classroom resources, lesson plans, and tutorials. This emphasis on incorporating the 4Cs is consistent with messages from President Barack Obama (2016) and former Secretary of Education Arnie Duncan (2010), who called on the country to invest in its future teachers. They reminded teacher educators that great teaching is critical to student success, particularly in STEM fields, through project-based, hands-on educational experiences.

STEMES responded to this challenge by hosting a one-day professional development conference, iSTEM 2017, on the campus of an urban, public university located in the Midwest. This conference highlighted innovative practices and emerging trends in STEM education. The conference attracted 250 pre-service teachers to learn current theory and best practices of STEM education and provide them with an opportunity to network with regional STEM professionals. The conference design was grounded in social cognitive theory (Bandura, 1986), constructivist learning theory

(Vygotsky, 1978), the theory of cognitive development (Piaget, 1954), hands-on learning or experiential education (Dewey, 1938), active learning (Bruner, 1966), motivation theory (Maslow, 1943), andragogy theory (Knowles, 1984), and gamification principles of engagement (Kapp, 2012). The STEMES community of practice designed the iSTEM 2017 conference to increase pre-service teacher confidence in STEM through hands-on, interactive and engaging workshops and seminars with a variety of strategies and lessons to add to their developing teacher toolbox.

iSTEM 2017 Conference Structure

During iSTEM 2017, as an introduction, the STEMES faculty mentors presented a short history of STEM education, as well as a summary of current educational trends. The attending pre-service teacher participants had the opportunity to choose two sessions from 20 possible workshops offered during concurrent sessions. The program featured sessions illustrating and demonstrating how STEM instruction can be planned, implemented and assessed in a variety of disciplines and educational levels. Innovative STEM research and theory were presented to help pre-service teachers to integrate STEM to successfully into their teaching and their students' learning. These experiences were intended to affect a generation of learners as the pre-service teachers use these strategies to help their own students develop critical thinking skills necessary to work and live in the 21st Century. Effective professional development offered in the conference could impact how teachers see themselves as STEM capable learners and educators.

Developing meaningful and personal connections as a STEM capable learner was a central theme woven into concurrent sessions and the keynote address. The keynote address was designed to empower the pre-service teachers to imagine how they might

incorporate these strategies in practical, concrete ways in any classroom, regardless of content. Throughout the day, regional STEM professionals offered advice on enriching classroom instruction and on creating relevant, real-world relationships for pre-service teachers and for their students. The conference concluded with a debriefing session facilitated by the STEMES cohort to encourage the exchange of ideas and lessons learned. The debriefing session also provided conference committees with the opportunity to collect conference evaluations and feedback. Following the iSTEM 2017 Conference, the proceedings of the conference were documented and made available online on the conference website at http://umsl-istem.weebly.com/ A limited number of printed copies of the conference proceedings will also be available (Appendix A).

iSTEM 2017 was designed to deepen students interest in teaching with the 4Cs by engaging them in fun, authentic, and meaningful learning experiences. Each session concluded with a metanarrative to explain the pedagogy underlying the experiences, calling attention to lesson designs and resources. Their design to help the pre-service teacher replicate the lesson in his or her own environment was instrumental to generalizing conference experiences. This metanarrative, supported by supplemental materials and links so that participants could teach these lessons on their own, was designed to increase pre-service teachers' confidence in teaching STEM concepts. With continued professional development and support from existing STEM professionals, it is hoped that the achievement gap can be narrowed in mathematics and science between advantaged and disadvantaged students. Narrowing the differences in opportunities and achievement will contribute to increasing the number of graduates in STEM disciplines, resulting in a higher skilled work force.

iSTEM 2017 was designed as an innovative approach to professional development, targeting pre-service teachers. Participants were immersed in varied approaches to STEM education from the perspectives of administrators, teachers, curriculum specialists and informal educators. The conference was designed to show participants 1) practical examples of STEM integration in elementary and secondary classrooms, 2) ways of measuring the quality of STEM programs, 3) easy ways to begin and sustain outdoor education programs, 4) best practices in technology integration in teaching, and 5) research in science education practice and pedagogy.

Throughout the conference, attendees participated in community-building experiences using game-based elements such as experience points and rewards to encourage a sense of play, competition, and camaraderie. The digital conference program offered an opportunity for participants to build social networks, share their enthusiasm about what they were learning, and access digital resources for each session.

The short-term goals for iSTEM 2107 included 1) conveying the importance of STEM integration into the classroom, 2) providing information about new and emerging careers in STEM, and 3) presenting research-based information on problem and project-based instruction. The long-term goals included 1) developing positive attitudes towards STEM among pre-service teachers, 2) infusing the culture of prospective school work environments with STEM, and 3) connecting participants to community resources and expertise (See Appendix B for the logic model containing these goals). Designed using Loucks-Horsley's professional development framework (2010), the iSTEM 2017 professional development conference inspired and helped prepare pre-service teachers to

integrate STEM education in their teaching practice. That improved practice, in time, will bolster student interest and preparedness to pursue STEM degrees.

GLOSSARY:

- iSTEM 2017: the conference proposed in this document
- STEM: Science, technology, engineering and math
- STEMES: STEM Educational Scholars, the STEM Education Scholars Community of Practice in the College of Education at a public university located in the Midwest.

Chapter 2

Literature Review

The burden of education reform rests on the shoulders of teachers whose individual and collective progression are facilitated through professional development (Duffee & Aikenhead, 1992). A teacher's understanding of pedagogy, content knowledge, and their familiarity with the district's curriculum provide the setting for their expectations of student learning outcomes (Lemov, 2010). Professional development provides opportunities for teachers to exert influence over their weakness and fine tune their strengths. Loucks-Horsley, Stiles, Mundry, Love, and Hewson (2010) believe that professional development programs are more likely to reach goals and impact student learning schoolwide when multiple dimensions of growth are addressed, rather than focusing solely on the development of individual teacher learning. Building and shaping the way professional development is conducted requires school districts to create a space where motivation, active learning, collaborative culture, in-depth investigation, and reflection are fixtures of any teacher learning activities that are focused on continuous learning.

The background information, provided in the literature review, will help frame the decision to host the iSTEM 2017 Conference. Providing students with a solid foundation in STEM is a central issue in K12 educations due, in part, to the increase in STEM-related occupations (US Department of Labor, 2017). Increasing the number of students interested in STEM fields is the plight that launched a nationwide campaign to develop stronger STEM education in K12 schools. Research from Goekmenglu and Clark (2015) supports a focus on content area expertise as well as making material relevant and

appropriate for the grade level being taught. STEM education exposes students to unique learning opportunities and prepares them with 21st century skills which could make a targeted influence on the percentage of students who declare a STEM major in college and go on to pursue one of the many STEM careers spoke about in 2017 report produced by the U.S. Department of Commerce.

The goals and objectives of delivering professional development at the iSTEM Conference were multifaceted. It was less about everyone having a carbon copy experience and more about participants experiencing personal growth with respect to teaching. Focusing on pre-service teachers was an investment in the future of STEM education (Business Higher Education Forum, 2014). In Yurtseven and Bademcioglu's (2016) analysis, the distribution of studies carried out between 2005 and 2015 on teachers' professional development with regard to the area of study is shown in Figure 1.

Figure 1

The distribution of studies carried out between 2005 and 2015 on professional development of teachers with regard to areas of study. Image Retrieved From: (Yurtseven, & Bademcioglu, 2016, p.224)

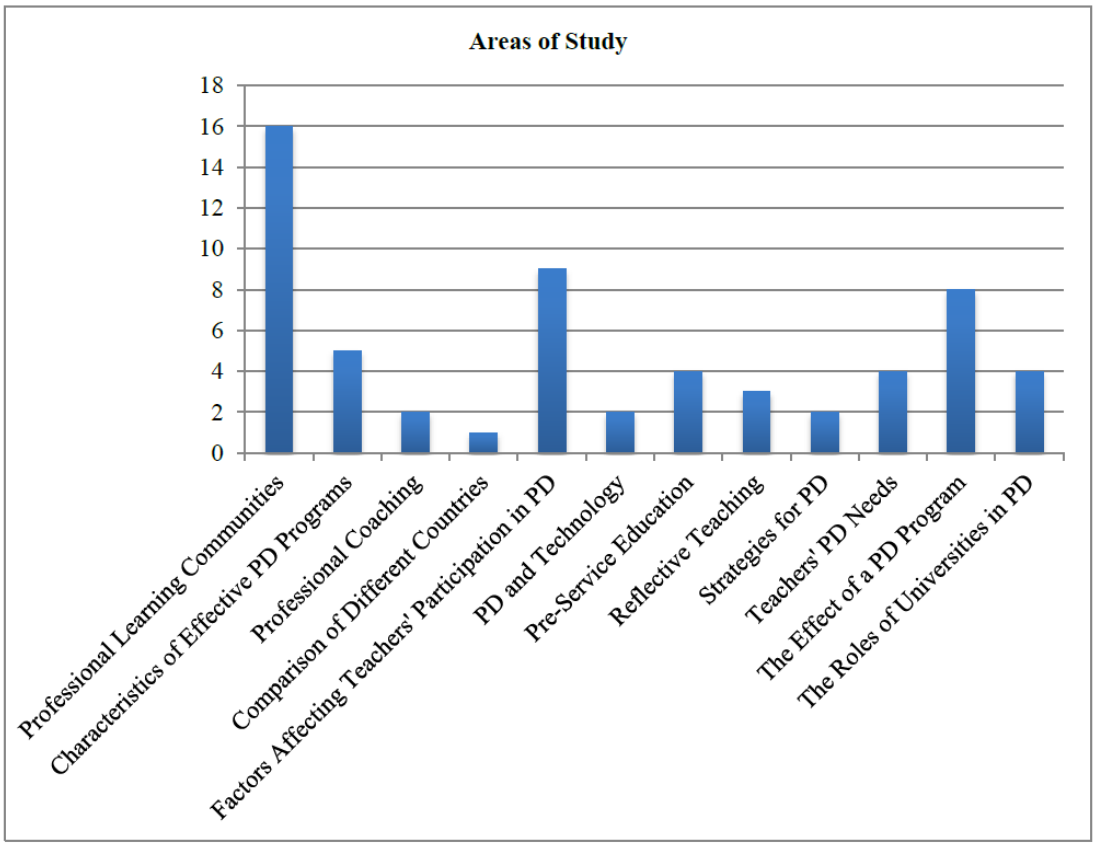


Image Retrieved From: (Yurtseven, & Bademcioglu, 2016, p.224)

Studies on the professional development of pre-service teachers are critically low. In response to the lack of attention shown to such an influential group of teachers, the STEM Educational Scholars designed a one day conference to stimulate the integration of STEM education into their teaching practices (Murley, Gandy, & Huss, 2015). The purpose of the iSTEM Conference was to provide pre-service teachers with research-based STEM theory utilizing collaboration and problem/project based learning, practical applications and experiences, opportunities to network with community resources, and various methods of assessment. To see the purpose through, the STEMES cohort identified 5 program outcomes or objectives to strive for:

1. Participants will learn why STEM integration has become so important.
2. Participants will learn how STEM skills can be integrated into their instruction.
3. Participants are likely to report increased commitment to integrating STEM into their instruction.
4. Participants are likely to report increased confidence for integrating STEM into their instruction.
5. Participants are likely to be able to recognize their learning moments and relate those to STEM skills.

Increasing the awareness and overall confidence in STEM education, for pre-service teachers, may act as a conduit to impacting their likelihood of introducing their students to STEM; thereby, creating more student interest in STEM fields.

STEM Education and Careers

In 2007, Congress passed the America COMPETES Act to address the declining number of students entering college and majoring in STEM-related degrees (Carnevale, Smith & Melton, 2011; Sousa & Pilecki, 2013, Chen, 2013; Junior Achievement, 2013; Business Higher Education Forum, 2014). This shortage of STEM scholars posed a problem for the upcoming STEM workforce (Education to Innovate, 2013; Moakler & Kim, 2014; Roger, Winship, & Sun, 2015 Langdon, McKittrick, Beede, Khan, & Doms, 2011, Fingleton, 2013, Rothwell, 2014,U.S. Department of Labor, 2015 & 2017). Some felt that students would lack the skills needed to be competitive in the upcoming job market (Zipkes, 2016, U.S. Department of Labor, 2017). A Study done by the U.S. Department of Commerce (2011 & 2017) show advantages gained by the U. S. from this

STEM workforce. In 2006 the U. S. National Academies expressed concerned about the state of the U. S. educational system and recommended redevelopment of the science, technology, engineering, and mathematics curriculum and content being taught in US schools. Moomaw (2013) states that the first true definition of STEM came from the National Science Foundation (NSF). It was in 2001 when Judith Ramalay, the former director defined STEM as any curriculum related to science, technology, engineering, and mathematics (Teaching Institute for Excellence in STEM, 2010). Her definition was aligned with the one given by the US National Academies in that STEM was the academic areas of science, technology, engineering, and mathematics. Although the definition has varied (Zhou 2011), another take on the definition of STEM categorizes the collective teaching of the four disciplines in an interdisciplinary and applied curriculum (Hom, 2014). Where they differs, according to NSF, was that true STEM involved the integration of some if not all of the STEM related skills much like the manner in which that or tied together in STEM related careers. If the U. S. was going to remain a superpower, it had to address these academic issues that could hinder its growth. Recently several reports have been published that state that there are STEM jobs available (Rothwell, 2013; U.S. Department of Commerce, 2011,2017; Teitelbaum, 2014; Cannady, Greenwald & Harris, 2014; Vilorio, 2014; Change the Equation, 2012 & 2014; Department of Education, 2015; Adecco, 2017), and there is a need for a literate STEM workforce.

Professional Development

Findings in Grimmett's (2014) research on professional development indicate the practice has only been in existence for approximately sixty years. Specifically stating,

> "Lieberman and Miller (2008) claim that staff development programs had their genesis in the US in the late 1950s and early 1960s as part of the National Defense Education Act of 1958 passed by Congress in response to the Soviet launch of Sputnik. These programs generally consisted of lectures and summer-institutes developed by university professors to transmit subject-specific knowledge, techniques and materials to teachers, who were in turn expected to apply these in their classrooms" (Grimmett, 2014, p.32).

In an annual report written by the Organization for Economic Co-operation and Development (OECD), professional development was defined as, "activities that develop an individual's skills, knowledge, expertise, and other characteristics as a teacher" (2009, p.49). This definition highlights the concept that the overall goal of professional development is to produce more effective teachers, enabling them to sharpen their skill sets so that they can provide the best education possible. Per a definition provided by the Burns (2014) in the Glossary of Educational Reforms, professional development can be loosely used to refer to several activities designed to improve the knowledge, competence, skill and effectiveness of teacher and administrators through the use of advanced learning, formal education, and specialized training. These advanced trainings may be state funded through programs and budgets such as Title II. The structure and design of these professional development sessions may vary as much as their funding source. The Global Partnership for Education (2017) identified five different models of Professional Development that were teacher centered and provided a brief description of each.

1. Observation and Assessment – In this model of professional development the teacher is provided feedback that is structured. This feedback in provided in a coaching type of relationship and is focused on assessing the teacher's instructional practices used in their classrooms. The PD provider is normally a master teacher, a specialist, or an experienced teacher.

2. Open Classrooms – The focus of this type of professional development is around behavior management. The teacher's lesson is observed by other colleagues and the feed is given in a post-observation structure and it is directly related to the handling of behaviors during the instructional process. When this type of PD is followed by a discussion that is open, truthful, and meaningful both parties benefit, and if the observed teacher can watch a more skilled teacher in action the results are powerful (Gaible & Burns, 2007)

3. Lesson Study – This a very useful method employed in countries like China. In this method teachers plan, develop, and improve a lesson in real time. Information is collected related to the lesson and changes are made as needed until the lesson is perfected and yields the desired student results. There are some barriers to this type of professional development because it focuses on all aspects of the teacher's lesson. This method has been documented as a proven way to enhance teacher's design and instructional skills (Stigler & Hiebert, 1999).

4. Study Groups – This method resembles common data-team meetings. In this professional development, teachers meet in an either larger of small group setting. There is a facilitator that leads the readings, discussion, or reflection activity. The aim is to analyze and address a common issue or problem, and most of the time the analysis is of student work.

5. Looking at Student Work – This is a method that looks at lesson development and improving the way and manner teachers plan. The focus is on student learning and not the teacher, basically, did the lesson accomplish the intended goal.

The above named methods are considered teacher centered professional development because they build communities of professionals where each person can, "enlist colleagues to help them critique and improve implementation of particular ideas or strategies, and customize, and adopt new skills and concepts to their particular setting" (Burns, 2011, p.190).

Theoretical Framework

Decisions about the iSTEM 2017 conference are guided by a central principle: meaningful engagement impacts learning (Barkley, 2009). The following interrelated imperatives contribute to meaningful engagement for teachers and their students:

1. Make the learning worth pursuing,
2. Foster a sense of competence,
3. Provide empowering support,
4. Embrace collaborative learning,

5. Establish positive relationships and community, and
6. Increase motivation and a desire to learn new things (James, 2015, para. 3).

These proposed golden rules of student engagement (James, 2015) are built on the shoulders of learning theorists such as Vygotsky (1978), Piaget (1954), Knowles (1984), Dewey (1938), Bruner (1966), Maslow (1943), and Kapp (2012). iSTEM 2017 modeled constructivist instructional strategies, to pre-service teachers, and illustrate how they can place students at the center of their learning, using STEM as a strategy, to promote student engagement and increase student performance.

Learning is the active process of building knowledge rather than consuming it (Mascolol & Fischer, 2005). Knowledge is constructed through personal experiences within a variety of contexts that shape how the individual receives information. In the constructivist classroom students organize new knowledge, explore concepts through questioning and exploration and actively participate in and reflect on learning (Brooks, 1999). Teachers focus on depth of understanding and assume a supporting or reflective role while students build meaning for themselves and engage in critical thinking and problem solving. The iSTEM 2017 conference offered a two-level model of this type of engagement; first in the sessions they experienced at the conference and second in the information and methods they learned about and adopt in the future.

Vygotsky's (1978) sociocultural theory of human learning emphasizes the critical role social interaction plays in learning, suggesting that learners must first interact with others before new knowledge can be integrated into the individual's mental structure. The concept of a socially constructed conference designed to maximize social interaction, discussion, and sense-making is built upon Vygotsky's theories.

Jerome Bruner's (1966) instructional theory informs the conference design related to the following learning objectives:

1. Sessions should contain experiences and contexts that make the student willing and able to learn.
2. Sessions should be designed so that the information and resources are accessible and easily grasped by the participant.
3. Sessions must fill in the gaps of what participants do not already know and should require them to think outside the box.
4. Sessions should help participants create new ideas and reframe prior knowledge in a new way.

STEMES selected proposals that embraced Bruner's (1966) theory that learning will occur through active participation via carefully designed and ordered interactions by experts. The call for proposals was written in a way that would appeal to speakers who would present meaningful information to pre-service teachers. Attracting the right speaker can reinforce the overall message and influence participants to shift their behavior (Schwartz, 2014).

John Dewey's (1938) view of education emphasized the need to learn by doing, a critical aspect of the philosophy of pragmatism. iSTEM 2017 featured a variety of hands-on experiences for participants to practice and experience the information they learned. The session room furniture was arranged in pods and clusters to support participants working in collaborative groups. The call for proposals placed emphasis on the importance of active, hands-on workshops that allowed participants to link experience with thinking as a function of the interaction of mind and body (Dewey, 1938). iSTEM

2017 offered a variety of sessions that were both interactive and practical, and modeled experiential learning methods in the curriculum.

Malcolm Knowles' (1984) learning theory, Andragogy, as cited by Kearsley (2010) suggests four principles for effectively engaging adult learners that were adapted to align with the goals and objectives of the iSTEM 2017 conference:

1. Learning is problem-centered,
2. Learners are most interested in topics that have relevance and impact on their careers/life,
3. Experience provides the basis for learning activities, and
4. Learners make choices in and take ownership of the learning process" (Kearsley, 2010. para. 4)

STEMES' decision to design the conference for pre-service teachers followed Knowles' (1984) characterization of adult learners. "As a person matures he/she accumulates a growing reservoir of experience that becomes an increasing resource for learning" (Knowles, 1984). Conference attendees will be entering the job market soon, and will be eager to learn new teaching strategies. In addition, pre-service teachers selected which sessions they would attend; thereby increasing the reservoir of experiences they can refer back to.

Motivation to learn and engage in the conference are predicated on three learning theories: Maslow's Hierarchy of Needs (1943), Bandura's social cognitive theory (1986), and Kapp's (2012) gamification of learning. Maslow (1943) believed that people possess a set of motivational systems that he arranged in a five-stage pyramid to represent a hierarchy of importance (see Appendix C for a figure illustrating Maslow's Hierarchy of

Needs). Maslow (1943) argued that a learner must satisfy lower level and basic needs before progressing on to meet higher level growth needs. For example, someone who does not feel safe is unable to fully develop self-actualization needs (fulfillment or realizing personal potential). Motivation is also increased when learners are able to build or create new experiences (McCombs & Whistler, 1997). The program design also focused on the fourth stage to build participants' esteem and confidence in teaching STEM subjects. Investing in pre-service teachers will ultimately motivate them to reach their highest level of growth (self-actualization) and realize their full teaching potential (Maslow, 1943).

Similarly, Bandura's (1986) social cognitive theory examined the role that motivation, affect, and personal action plays in the learning process. He claimed that learning most likely occurs when the learner has a sufficient amount of self-efficacy, the belief in one's capabilities and skills. Self-efficacy can be developed or improved by performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal (Bandura, 1977). In the context of learning during a conference, participants can become more motivated, active and attentive if they have practiced what they are learning with others when guided by an expert who provides encouragement during the activity.

Like Maslow, educational technologist Karl Kapp (2012) also focuses on participant motivation and engagement in the learning process. Kapp's (2012) research on gamification, in instruction dovetails Bandura's (1977) emphasis on the emotional state of learners. The use of game-based elements such as leaderboards, experience points, rewards, and achievements during instruction increases learning, retention, and application of information because it relaxes the learners and taps into their creativity

(Kapp, 2012). The use of gamification during instruction or training taps into the natural desire for competition, achievement, and status (Figueroa-Flores, 2016). Though formal research on gamification in education is in its nascent stages, it is widely used in business to increase engagement in training programs resulting in improved performance (Hamari, 2014; Cahyani, 2016). iSTEM 2017 participants experienced a series of gamified activities that rewarded participants for participating in discussions, asking questions, visiting exhibitors, sharing feedback, and contributing ideas.

Mechanisms for Effective Development of Professional Development Conferences

Schlechty and Whitford (1983) categorize professional development as serving at least one of three functions: 1) Establishment – increase awareness, 2) Enhancement – improve practice, and 3) Maintenance – continued practice/ensure compliance. In thinking about facilitated learning opportunities for pre-service teachers, the cohort identified the need for a large-scale program centered on increasing awareness of STEM Education. The idea of a working-conference combines traditional aspects of both a conference and a workshop into one event. A conference is a structured approach to professional development that involves leaders who are specialized in a particular area and participants who attend sessions at a structured time **(**Garet, Porter, Desimone, Birman, & Kwang, 2001). There is a framework that must be in place in order for the Professional Development to achieve its goals (Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010). Some of the major participant benefits attributed to using the conference model include:

1. Opportunity to choose sessions from a variety of offerings,

2. Sessions that feature current and relevant information, and
3. A chance to work with peers for an extended, uninterrupted period of time (Bredeson & Scribner, 2000, p.6).

The engaging atmosphere of a working-conference facilitates critical thinking that empowers goers to become active participants in their own on-going education.

Collective participation in an activity provides a space for improved understanding of a concept and increases participants' capacity to grow. Focusing on pre-service teachers, from the same university, was a deliberate choice with the intention of having students thoughtfully contribute to their programs of study under one theme. Birman, Desimone, Porter, and Garet (2002) describe collective participation as active engagement from teachers in the same department, subject, or grade. Professional development, in a conference setting, allows for information to be exchanged among peer groups that may not otherwise interact with each other on a daily basis.

Conferences can provide participants with exposure to information from multiple viewpoints. Conferences match participants' needs and interests with an array of informative sessions tailored to complement their background. Professional development, designed for large groups, allows participants to discuss experiences and integrate what they learned with other aspects of their shared instructional context (Garet et al., 2001). Stephen Brookfield (2013) reminds conference planners of design elements to consider:

1. Be clear about conference goals and why it will be helpful for them,
2. Create opportunities for participants to share their own past experiences,
3. Share a real-world and salient problem or experience that has researched solutions to learn,

4. Encourage questioning from the participants through back-channeling or interactive workshops,
5. Design sessions that provide more than one way to learn, and
6. Allow time at the end of the conference for participants to think aloud and share ways that they use the information they have been exposed to during the conference **(**Brookfield, 2013).

Designing a large-scale professional development conference came with responsibility of creating an engaging day of events that was tailored for pre-service teachers. McCarthy's (1960) 4P's conceptual framework for marketing proposed using the marketing mix of product, price, place (or distribution), and promotion to position a new service to a group. Understanding how to position our service (the iSTEM Conference) was paramount in creating value in the eyes of conference goers that matched or exceeded their expectations of a professional development conference. Thus, the iSTEM 2017 committee planned a format of events that offered a variety of session topics catering to teachers at various grade levels and subject areas following the suggestions of President Obama (2011), and studies like (Junior Achievement, 2013, Rogers, Winship, & Sun, 2015, Change the Equation, 2012). Kapp's (2012) suggestions to enhance these informative sessions with game-based elements, such as experience points (in the form of beads) and leaderboards motivated pre-service teachers to stay engaged throughout the conference.

Assessment, Evaluation Procedures, and Instrumentation

Professional development tends to be most effective when concepts are introduced before a teacher begins a career, or in the early years of their career (Ebert-May, 2011). Three critical levels of professional development feedback was collected during iSTEM 2017, based on recommendations by Thomas Guskey (2002). These levels identified how participants felt about the conference, whether or not they learned as they anticipated and if their reflections show evidence of intended growth. A fourth level suggested by Guskey (2002) was be to survey faculty members with respect to impact noted in discussions and the likelihood of transfer into the pre-teachers' instructional strategies toolkit. It was an expectation that pre-service teachers participated in engaging presentations, had time devoted to reflect on what they learned, and space to strategize about how they will use what they learned. Reflection is paramount in the development of teachers because it builds a bridge between how the participants learn and what their students might find engaging (Isaacson & Fujita, 2006; Pilegard & Mayer, 2015; McFadden, Ellis, Anwar, & Roehig, 2014). Reflections were done using open-ended questions as well as through the use of data visualization tools such as Wordle, which brings text to life highlighting the most frequently used words (Viegas, Wattenberg, & Feinberg, 2009; McNaught & Lam, 2010).

Jerardi, Solan, DeBlasio, O'Toole, White, Yau, Suchare, and Klein (2013) explored how to evaluate the experiences of conference attendees. They claimed that conferences designed to control information dissemination tend to feature sessions with PowerPoint lectures. Conferences designed to foster interaction tend to have sessions using multimedia, audience participation, and mentorship. Their data showed no

significant difference in knowledge acquisition between the PowerPoint group and intervention groups; however, learners and presenters reported higher satisfaction with interactive engagement. Having our conference focus on interaction promised to increase engagement that will, hopefully, translate into knowledge acquisition, familiarity with content, and confidence in skills. It will also provide appropriate modeling of instructional best practices.

The purpose of sponsoring a professional development conference was to provide pre-service teachers with research-based STEM theory that utilized collaboration, with practical applications, and allowed participants the opportunities to share their learning with each other. In order to determine whether the conference goals are met, evaluation measures assessed: 1) Whether pre-service teachers have increased their content area knowledge and 2) whether they felt more confident in teaching STEM topics. Kelley and Morath (2001) studied methods for measuring organizational change that can be applied to institutional transformation. iSTEM 2017 organizers sought to encourage change in traditional instruction by encouraging a mindset favoring STEM and collaboration. Kelley (et al., 2001) reported on Shewhart and Fisher's "Plan, Design, Study, Act" experimental design model. Pre and post-surveys are given to measure the level of satisfaction within the groups. iSTEM 2017 was structured to perform such an experimental type of evaluation. Pre and post evaluations were used to measure knowledge acquisition, and change in thought and attitudes following the iSTEM conference.

STEMES used the New Learning (NL) evaluation process to structure and design the surveys for the conference. New Learning focuses on how and what conference

participants learn (Chapman, Wiessner, Storberg-Walker & Hatcher, 2007). NL requires that participants submit forms with accounts of what they learned throughout the conference, not just at the end. NL encourages two-way communication discussing how to use information that was learned. The New Learning (NL) evaluation process consists of reflective evaluations after each session and in-depth structured interviews with selected participants. NL attempts to capture learning as it happens. NL is constructive, dynamic, and allows unidentified factors to be recognized. NL avoids creating an "*us versus them"* relationship between conference participants and conference organizers. Instead, NL is a **"**collaborative process that focuses both participants and organizers on a field, theory, or practice" (Chapman et al., 2007, p 267). Ideally, New Learning provided attendees with new ways of thinking about evaluation. Such an evaluative process can help attendees understand how engagement with others can generate knowledge and promote transformation in their practice (Weimer, 2012).

Chapter 3

Research Methodology

Due to the decrease in the number of students pursuing STEM related degrees and careers in the United States (Carnevale, Smith & Melton, 2011; Business Higher Education Forum, 2014; Chen, 2013), the STEMES cohort decided to challenge this trend by organizing an educational conference. The focus of this conference was to increase participants' familiarity with STEM education, their confidence in integrating STEM into their practice, and their understanding of the importance of integrating STEM. Attending a successful conference, especially when one is surrounded by others sharing similar professional interests and goals, can be motiving about engaging in new learning strategies. When planning a conference, it is important to be reminded of the reason for organizing the conference. Keeping this focus during the planning aided STEMES in decision-making along the way. One of the first and most important steps in organizing the iSTEM conference was establishing conference committees by identifying individuals responsible for different aspects of the event. Committees were developed and designed by the STEMES Community of Practice cohort several months prior to the event based on the conference objectives. Personnel needs and logistical supports were identified. A detailed explanation of each committee is described in this chapter.

Conference Committees

The Conference Steering Committee. This committee coordinated the work of all the conference subcommittees to ensure that the overall conference design and planning was time conscious and considerate of budget limitations. The conference chair was

responsible for overseeing the conference, and participated as ex officio member on all conference subcommittees. There were two additional members that served as principal subcommittee chairs of the conference program and proceedings document.

The conference chair provided a planning timeline for each subcommittee by seeking information on deliverables and deadlines from each group. The timeline presented a critical path to success for the committees; however, it was not an all-inclusive list of responsibilities. A sample of the timeline can be viewed in Appendix C. Completion of each task was a combined effort of all members of the committees.

Additional responsibilities included performing weekly check-ins, where committees reported on their progress. The chair provided supporting resources to the subcommittees as needed. A major contribution, from the conference chair was the suggestion that the committee consider gamified activities during the conference to reward attendees for asking questions and volunteering to participate. Necklace beads with point values were redeemable for tickets to win prizes. The steering committee was credited with providing templates for the program layout, leading class discussions, incorporating participant needs within logistical constraints, and building session tracks to maximize student engagement.

The Proceedings Committee. This committee produced a document that presented a description of the conference. The Proceedings Committee was established to organize and produce the biographies of presenters, copies of the presentation documents and analyses of conference evaluations. The committee provided a document which accurately and thoroughly reported the essence of our conference. This document was archived in print and digital formats. The proceedings provided research-based

information that could be used by pre-service teachers to understand, implement, and evaluate their STEM instruction. Members of this committee worked closely with the evaluation committee to create items for the conference evaluation. The conference proceedings document includes a copy of the schedule, seminar strands, and presenters' biographies. (See Appendix A for proceedings document).

The Proposals Committee. The goal of this committee was to attract a diverse group of presenters who would carry out the vision of the conference. Because inspiring and informing pre-service teachers were major goals of the conference, the proposals committee worked to identify and select presenters who were passionate, influential, and who would connect with the iSTEM audience.

Successful conferences are in large part due to the quality of invited speakers. "Your list of speakers is one of the biggest draws at your conference. The speakers' notoriety and knowledge lends legitimacy to your programs and builds anticipation" (Schwartz, 2014, para.1). Successful conferences also require much more from presenters than just information sharing. Engaging the audience and being present and accessible during the conference are essential habits of a good conference presenter. Proposals for presentations were invited through emails, phone calls, and personal communications.

The proposal committee determined the following information was to be collected from each proposal submitted:

- Source of information about the iSTEM conference
- Affiliation / School / Institution / Agency
- Title of Proposed Session

- Subject Area(s) that the presentation would address (Science, Technology, Engineering, Math, or Interdisciplinary)
- Grade span the session would address (Pre-K thru 12th)
- Abstract (Overview of the Presentation)
- Session Summary (including a plan for engaging the participants)

Immediately following the proposal submission deadline, proposals were analyzed and scored (#1-10) based on the following criteria:

Proposal Thesis/Outcome (#1-10 Lowest to Highest)

- Session clearly defines outcomes aligned to iSTEM goals
- Participants are likely to walk away with something they can use
- Theoretical Framework/grounded in research

Topic (#1-10 Lowest to Highest)

- Creative / novel / unique topic
- Timeliness of topic, subject matter
- Evidence of depth of experience / expertise / they model what they will tell others

Aspects for Variety of the Program (Scores not included in total)

- Fills gap in the program
- Fills gap in objectives / goals
- Fills gap in appeals for specific audience, sub-group(s)
- Fills gap in cultural diversity

Track Identifier (Scores not included in total)

- Pre-K

- Elementary Education
- Middle School STEM related
- Middle School non-STEM related
- High School STEM related
- High School non-STEM related

Objectives Aligned (Scores not included in total)

- Participants will learn why STEM integration has become so important
- Participants will learn how STEM skills can be integrated
- Participants are likely to report increased confidence for integrating STEM
- Participants are likely to be able to recognize their learning moments and relate those to STEM skills

The two categories that were not scored were used to help organize selected proposed sessions. The criteria used were designed to be compatible with the five objectives for the conference that were introduced in Chapter 2.

Each proposal was scored anonymously by each member of the STEMES cohort. The proposal committee used those scores to determine who were selected as speakers for the conference. In addition to selecting session speakers, a keynote speaker was also selected to build excitement for STEM and motivate the audience. The keynote speaker selected by the proposals committee had a passion for STEM education and was known around the community as an advocate for STEM.

Conference Branding/Theme and Design Committee. This committee was charged with developing the marketing strategy, creating the conference's name and developing the overall image of the conference. Having pre-service teachers as the consumer base

(audience) warranted the creation of a design that would appeal to this target group. Working collaboratively with the website committee, the iSTEM logo was created to anchor the marketing campaign. Additional milestone activities can be seen in Appendix E.

The Website Committee. The website committee created a website to promote iSTEM 2017. The website showcased the iSTEM 2017 conference logo, provided an overview of the purpose and goals of the conference, and displayed profiles for conference committee members. The site also contained guidelines and expectations for proposal submission as well as a proposal submission link. The website committee designed and launched a conference registration form, managed registrations, confirmed registrations received, and developed and launched promotional material. The iSTEM website was established at the following universal resource locator (URL): http://umsl-istem.weebly.com.

The Marketing and Advertising Committee. This committee performed public relations, planned a distribution strategy for iSTEM 2017 materials, and created/conducted promotional campaigns as a means of communication between conference organizers and the audience of pre-service teachers. The iSTEM 2017 marketing campaign used tenets of McCarthy's (1960) Marketing Mix of product, price, place, and promotion. Advertising was supported by tools such as raffles/door prizes, banners, and posters. The marketing committee induced interest in the iSTEM 2017 Conference and worked to include activities and products that would encourage attendees to seek more information on STEM education.

The Sponsors and Exhibitors Committee. The Sponsors and Exhibitors committee solicited support from companies, agencies, firms, and corporations that have a vested interest in the successful implementation of STEM instruction. The sponsors were asked to provide either financial or material support that was used to offset the possible cost of hosting a keynote speaker.

The Volunteer Recruitment and Scheduling Committee. The committee's purpose was to establish conference procedures and systems that made it possible for volunteers to have a valuable experience. This committee recruited and coordinated schedules for conference volunteers. The primary focus was to recruit friendly, eager, engaging, and productive volunteers.

The Registration and Name Badges Committee. Registration was online with a "save-the-date" reminder sent out to pre-service teachers. Upon arrival, attendees checked in to pick up their name badges, and signed a letter of consent to allow the cohort members to collect data during the conference. The registration committee assured that each participant who registered and checked in received a necklace and one bead to start the gamification process. Those participants that registered late or not at all were directed to a different table to get the necessary information and to explain the gamification process along with other conference dynamics. All participants were encouraged to download the *Guidebook* ® application which provided information on the sessions, presenters, keynote speaker, times, locations, and reminders.

The Audio Visual Committee. A survey was created for presenters to request specific audio / visual equipment, and to inform committee members about software available through the venue. The committee members checked projectors and smart

boards for proper functioning, and ensured working microphones and wireless clickers in each room. When the speakers arrived at iSTEM 2017, committee members ensured that presenters' computers could connect to any required equipment for their sessions.

The Facility Technical Liaison Committee. Planning, scheduling, and coordinating technical requirements for the conference was the responsibility of this committee. This group served as the intermediary with the university's Technology and Learning Center (TLC) director. The technical liaison committee worked to ensure quality technical support for conference speakers.

The Catering Committee. This committee worked directly with the catering service offered by the University. Breakfast items were set up an hour before registration began. Utensils were provided by the catering company. Catering was set up near registration so participants could easily locate and collect the items of their choice. Lunch was located in the largest conference room to accommodate the number of attendees. Box lunches were chosen for efficiency. An afternoon snack was provided for participants and presenters.

Dietary restrictions were noted when participants registered so meals and snacks were provided to fit those needs. The university catering service was contacted three months prior to the conference when a clearer idea of the number of participants had been established. From then, bi-weekly contact was made to keep them informed of our needs. One week before the conference, the final arrangements were made with the catering service.

The Evaluation Committee. This group collected and organized meaningful feedback from conference participants with respect to logistics and professional value of

the sessions. New Learning (NL) evaluation was used at iSTEM 2017 to capture learning as it happened. NL focuses on how and what conference participants learn (Chapman, Wiessner, Storberg-Walker & Hatcher, 2007), by submitting feedback throughout the conference, not just at the end. The committee worked to make this process easily accessible to all participants. Surveys were developed in July and printed in September, 2016. Incentives to complete the surveys were embedded in the conference program. For convenience, the evaluations were also available through Guidebook ®.

Kelley and Morath (2001) analyzed organizational efforts to affect changes and note the futility of attempting to change people without measuring effectiveness. This phenomena was of interest because the objectives included changes in participant commitment to integrate STEM into their teaching and changes in their confidence levels for doing so. Kelley and Morath (2001) recommend measuring attitudes before and after treatments to determine attitude shifts.

New Learning Theory and Professional Development

Thomas Guskey (2002) recommends several critical levels of professional development. The first level evaluates participant reactions, including how participants feel about the conference, whether the refreshments were good, and if they liked the presentations. However, Guskey's second level of evaluation determines whether participant reflections show evidence of intended growth. This second level aligns with New Learning (NL), an evaluation process focused on how conference attendees learned, what they learned, and the significance of their understanding. NL is aligned with constructivist theory and is the evaluation process used for iSTEM because of its focus on

transformational learning (Chapman, et al., 2007). The New Learning evaluation process consisted of reflective evaluations after each session and in-depth structured interviews with selected participants. NL attempts to capture learning as it happens. NL avoids creating an "*us vs. them*" relationship between conference participants and conference organizers" because presenters are also learning as they interact with attendees (Chapman et al., 2007, p 267). Ideally, New Learning provides attendees with new ways of thinking about evaluation as participants reflect on their own learning moments and reflect on seeing others learning as well. Such an evaluative process can help attendees grow in their understanding of how engagement with others can generate knowledge and promote transformation in their practice. iSTEM evaluation and reflection instruments were designed to document the NL experiences. Pre- and post-evaluations were used to measure shifts in participant commitment to integrate STEM and changes in their confidence levels between the time of registration and the end of the conference day.

NL also requires that participants submit forms with accounts of what they learn throughout a conference, not only at the conference conclusion. NL encourages two-way communication with respect to how information being learned can be put to use. It is a collaborative process that focuses on both participants and organizers in a field, theory, or practice (Chapman et al., 2007, p 267). Ideally, New Learning provides attendees with new ways of thinking about evaluation. This method of evaluation may be used to demonstrate how knowledge can be constructed collaboratively and shared through scholarly publications and presentations. Such an evaluative process can help attendees understand how engagement with others can generate knowledge and promote transformation in their practice.

Three critical components of professional development feedback were collected during iSTEM 2017, based on recommendations by Thomas Guskey (2002), Kelley and Morath (2001), and New Learning (Chapman et al., 2007). These components identified how participants felt about STEM integration (confidence, familiarity, beliefs), whether or not participants' reflections showed evidence of intended growth toward STEM integration, and how participants learned during the conference. A fourth component, based on the work of Guskey (2002), was used to determine the likelihood that pre-service teachers would use what they learned in their future classrooms. All these evaluations were focused on determining the extent to which the conference accomplished its objectives. As described in Chapter 2, the objectives of iSTEM 2017 were:

1. Participants will learn why STEM integration has become so important.
2. Participants will learn how STEM skills can be integrated into their instruction.
3. Participants will increase their commitment to integrating STEM into their instruction.
4. Participants will increase their confidence for integrating STEM into their instruction.
5. Participants will recognize times when they learned something new and significant (a "learning moment"), and will relate learning moments to STEM skills.

For each objective, a null hypothesis was established:

1. Participants did not learn why STEM integration has become so important.

2. Participants did not learn how STEM skills can be integrated into their instruction.

3. Participants did not increase their commitment to integrating STEM into their instruction.

4. Participants did not increase their confidence for integrating STEM into their instruction.

5. Participants did not recognize times when they learned something new and significant (a "learning moment"), and did not relate learning moments to STEM skills.

Development of Evaluation Questions

The Evaluation Committee was established to design the questions and logistics systems to collect, organize, and analyze feedback from conference participants in order to determine the extent to which iSTEM goals were met. The first step toward developing a plan for evaluation was to determine precise objectives to be evaluated. A list was submitted to the entire cohort. Some adjustments were made, and the final list of objectives was unanimously approved. The objectives to be evaluated were aligned with the logic model for the iSTEM conference with respect to improving attitudes toward STEM.

Evaluation questions were solicited from the entire cohort. Over 130 questions were amassed before the evaluation committee condensed the list to 52 questions. They were reworded, formatted, and aligned to the approved objectives in two separate formats, Qualtrics online and paper copies in case of an emergency. One survey was

designed for the conference in general, and one for session reflections. The Google forms included a five-point Likert scale for each question so that cohort members could quickly rank the questions according to importance. Having the objectives along with the questions helped maintain the focus for the conference organizers. In the process of selecting questions, it was determined that clarifications to the objectives needed to be made in terms of numbering and separating one of the objectives into two. Ultimately, 15 questions were adopted and included in the Internal Review Board (IRB) submission packet along with two additional questions that were planned for lunch-time interviews but evolved into informal observations due to time constraints. The pre and post evaluation questions were identical, in line with Kelley and Morath's (2001) recommendation to measure attitudes before and after treatments. The reflective session evaluation questions were aligned with NL. The summative evaluation questions were a mix of Kelley and Morath (2001) and NL. Debriefing questions were intended to determine the likelihood of transfer into the pre-teachers' future classrooms. This decision supported Guskey's work which examined the likelihood that participants would use what they learned. (2002). The approved questions are listed in Appendix (E).

Population and Sample

In the early stages, it was decided that the invitees would include K-12 current teachers and administrators from the metropolitan area. The difficulty that arose was concern over the date selected to host a professional development as area teachers may have difficulty attending. During the discussion, the cohort learned that the university held "Grand Seminars" for their pre-service teachers on the first Friday of every month.

The purpose of the Grand Seminar is to supplement the pre-service teachers' experiences with resources they might not receive in their schools. With this new knowledge, it was decided to reach out to this group to start discussions about whether STEMES could host our iSTEM conference in place of their regularly scheduled Grand Seminar with pre-service teachers serving as the obligatory participants. The invitation was accepted and the date was fixed. The only request from the Grand Seminar organizers was that we should provide sessions that would be useful and beneficial to K-12 teachers in any content area.

Two hundred and fifty pre-service teachers were in attendance at the iSTEM 2017 conference. These attendees were K-12 student educators, whose content areas included: math, science, social studies, English language arts, physical education, art, foreign languages, early childhood education, and music. The STEMES originally were going to hold the conference at a smaller venue that was centrally located on campus, but later decided to move to another space that could accommodate a larger meeting. The location selected had a central area that could be used for registration, gamification information, breakfast and snacks, as well as a place for participants to gather to share what they learned. This new space included various size rooms for breakout sessions, as well as a large area to accommodate plenary sessions for lunch, closing remarks, and distribution of prizes. A large auditorium was also available to begin the day for opening remarks and the keynote address.

Evaluation and Assessment Instruments

Data collection instruments were originally planned as traditional paper handouts. As the cohort grew in their knowledge of technology, it became apparent that data collection should be electronic. Conference apps such as Whova (https://whova.com/) and *Guidebook* ® (https://guidebook.com/) were considered. These applications serve as a unified communication medium including the program, the ability to sign up for sessions, inter-participant communication, and the ability to fill out surveys, reflections, and post pictures of learning experiences. Guidebook was chosen due to its features and familiarity. Several electronic survey instruments were discussed including Google Forms and Survey Monkey. Qualtrics was chosen as the collection tool because of its versatility in question type and long-established record for reliability among users at the university. Paper forms were available as an emergency backup in the event of internet service disruptions. For data security and privacy, the Qualtrics account was password protected with access granted to two members of the cohort, to help maintain the participants' anonymity. All cohort members had access to the rest of the data being collected. Two of the STEMES cohort members monitored the number of evaluations being submitted and sent reminders to those who failed to complete them prior to the conference day. No information gathered was connected to an individual responding to the questionnaire.

Internal Review Board Project Proposal

Attaining approval of the Internal Review Board (IRB) was necessary before collecting data. The STEMES IRB Committee wrote the proposal as a group document, and submitted it to the College and University IRBs for approval. As a group project,

one STEMES cohort member individually submitted an IRB application listing the entire STEMES cohort as co-investigators. The main purpose of the IRB is to protect the privacy of the participants ensuring no harm would be done, and noting that participants did so willingly. The IRB also included the method by which the confidentiality of information and participants' identification would be protected. Approval was obtained.

Evaluation and Assessment Sequence

Pre and Post-Conference Survey Methodology. The conference evaluation process began before the conference with a pre-evaluation consisting of five online questions in Qualtrics which participants received during registration and ended shortly before participants were dismissed when participants completed a post-evaluation composed of the same five questions. (See Appendix E) Those five questions assessed prior familiarity with STEM, confidence in their ability to incorporate STEM, and understanding of the importance of STEM. Evidence of growth was shown by comparing the pre-evaluation responses with the post-evaluation responses.

The first three questions on the pre and post-conference online questionnaire used interactive sliders that gathered quantitative data from the participants responding to the survey. The last two questions were open-ended, and in analysis, the responses were categorized quantitatively to assess frequency. The pre and post conference evaluations were administered online through Qualtrics, a web-based survey tool used to conduct survey research. The data collected with the pre-conference evaluative questionnaires were completed by the participants online using Qualtrics. The post-conference evaluative questionnaires were completed online with the exception of five that were

completed on paper. The data from the five paper questionnaires were entered into Qualtrics anonymously to provide consistency in analysis.

Quantitative data was gathered from the participants responding to questionnaire items. A pair of subcommittee members analyzed the questionnaire items, and reviewed and critiqued all analyses. A table of values was constructed for responses to the first three questions, from which bar graphs were constructed to compare pre and post responses. The last two questions were open-ended, and the responses were coded and identified by broad categories. This type of coding was utilized to report the analyses in frequency charts. Frequency distributions were used as visual displays to organize and present frequency counts so that the information was interpreted more easily. Frequency distributions were used to show absolute or relative data such as proportions or percentages.

The minimum, maximum, mean, standard deviation, variance, and count were tabulated using the Qualtrics software. The results were used to construct bar graphs and pie charts, and data for each question was analyzed to determine change between the pre and post results.

Four types of analyses were done on the pre and post conference evaluative questionnaires. A general comparison was made comparing the entire pre- sample responses to the entire sample of the post- responses. A second analysis was conducted making a one-to-one comparison of the pre and post responses for a small sample of 56 participants. A third analysis was a frequency word count conducted to gauge change in the mindset of the participants. The fourth type of analyses conducted were paired and unpaired T-Tests.

Sessions Evaluations Methodology. Each of the two conference sessions with parallel sessions had a ten-minute period built in for responding to survey questions that included a combination of selection, scaled, and open-ended questions. Those questions attempted to capture an understanding of what participants learned and how they learned.

The Conference Sessions Evaluations were predominantly administered online through Qualtrics, while others were completed on paper. The data from the paper questionnaires were included in the data reported.

The first question was an open-ended question in which the responses were collected and quantitatively assessed by determining the frequency of words given. The website Text Fixer (www.textfixer.com) was used to analyze all of the responses to Question One. A word count was tallied and themes were generated using the words included in the coding. Questions two and three were selected response where survey participants selected the answer(s) that best represented their learning. Tables were created to display the quantitative data, as well as a bar and pie graph was included in the data report. The last two questions (Questions Four and Five) on the session evaluations were sliders which reported the participants' responses quantitatively. The minimum, maximum, mean, standard deviation, variance, and counts were tabulated using Qualtrics. The paper surveys completed by participants were used to construct bar graphs to display the responses given on the survey.

Summary and Debriefing Sessions. In the last session of the conference, participants reflected on their experiences and shared their new ideas by completing a summative evaluation and debriefing questions. The summative evaluation was created

to gather additional information from the participants to gain an understanding of whether or not their conference experiences helped them meet the conference objectives/goals.

Conference participants were actively and collaboratively involved in problem-solving activities during the workshops. The conference participants also had an opportunity to discuss conference experiences during the debriefing session at the end of the day. During this period, each group or gallery of students met with their Clinical Educator to discuss what had been seen, heard, learned, and experienced. Clinical Educators are ten experienced teachers who are assigned by the university to meet with pre-service teachers. As part of their clinical experience, a group of fifteen to twenty pre-service teachers in a group called a "gallery" meet weekly with a Clinical Educator. In their meetings they discuss things like pedagogy and classroom management. The Clinical Educators also observe the pre-service teachers, and grade assignments to be submitted to the state teacher certification department. These Clinical Educators are responsible for supporting each of the pre-service teachers throughout their last two years of their education certification. At iSTEM 2017, each gallery of pre-service teachers had a STEMES cohort member facilitating the discussion, along with the gallery's designated Clinical Educator. The groups shared what they had learned and discussed how it could be applied to their classroom instruction. In this way, participants were encouraged to consider incorporating some of their new ideas into plans for their School Adventure into Learning (SAIL) portfolios projects. SAIL projects include presentations that pre-service students are required to give to the university community. The purpose of each SAIL project is for the pre-service teacher to identify a need in the school, and to develop a way to help address that need.

Videos and/or audio recordings captured the debriefing session to facilitate analysis and to enable the researchers to detect patterns in what participants learned, how they learned, and how they valued the experience. The data collected during these sessions were both quantitative and qualitative. The videos and/or audio recordings were available through the Teaching Channel (https://www.teachingchannel.org/) for annotations by anyone who attended the conference. Teaching Channel serves as an outlet that districts and teachers can use as teaching tools. Users can upload videos of their own teaching and share with others. It was also believed that the sharing process would build a sense of momentum toward STEM integration, commitment to follow through, and retention of new learning for teaching STEM. Participant reflections were as much about *how* they learned as they were about *what* they learned. The inclusion of this kind of reflection was inspired by Randy Isaacson and Frank Fujita, who studied the effects of metacognitive processes by 84 undergraduates in an educational psychology class (Isaacson & Fujita, 2006). Isaacson and Fujita connected the findings from previous studies showing a relationship between self-regulated learning and academic success with the process metacognition. The perceived retention benefits were more recently affirmed in science classes by Pilegard and Mayer (2015). These reflections are intended to memorably connect the participants' ways of learning with the ways their own students learn or will learn. It was anticipated there would be evidence that participants see that STEM learning is highly effective across disciplines.

*Observations and Word Reflection Methodology***.** Participants were encouraged to snap a photo when a learning moment occurred during the conference. An incentive was provided for participants to post these pictures of their learning moments on *Guidebook*

® for further data collection. The goal was to encourage interactive sharing. Pictures and chats captured learning moments as they happened, both formally in sessions and informally outside of sessions. These photos were collected throughout the day and the pre-service teachers were rewarded for their participation by earning a bead reward each time they reported a new photo had been taken.

During lunch, the participants were also asked to reflect on their experiences and describe them by writing three words on an index card. The participants were asked to enter words on the cards that would later be used to produce a Wordle, a "web-based tool for visualizing text" (Viegas, Wattenberg & Feinberg, 2009) by creating word clouds in which "the more frequently used words are effectively highlighted by occupying more prominence in the representation (McNaught & Lam, 2010). The Wordle was intended to be a record of the participants' reflections. There are several programs that can be used to generate word clouds (e.g., Tagul, Word Cloud, and Word it out). Wordle is one such program that provides a correlation between word size and word frequency. Wordle is a tool allowing for "social visualization" of ideas (Viegas, Wattenberg & Feinberg, 2009). The more frequently mentioned words appear larger, while less frequently used words have smaller fonts. The words are organized in horizontal and vertical directions. The word orientation has no quantitative correlation to the word frequency. Although Wordles have been used as supplementary visuals in qualitative research, they have never been utilized as the primary data analysis tool (Viegas, Wattenberg & Feinberg, 2009). Participants were able to collaborate with their peers during a social time and generate the words about STEM. Participants were able to have discussions, albeit brief, to list their terms during the social time. The National Council for Accreditation of

Teacher Education states that reflection is seen as an important element in the development of teachers, and, "…a central concept in national guidelines for teacher preparation and induction (as cited in McFadden, 2013). The conference participants had many other opportunities for reflective meta-cognitive experiences.

Limitations

The evaluations in this dissertation were all self-reported. Self-reported data has well known disadvantages and advantages (Gonyea, 2005). The limitations of self-reported data were considered, but for evaluating iSTEM 2017, the STEMES cohort made the judgment that self-reported data was the most useful measurement tool practical for assessing the conference objectives.

All surveys (except for the debriefing survey) were completed individually by each participant. Survey results may not be without some bias as respondents may have completed the survey because that was the expectation and not giving much thought or insight into the questions being asked. The participants may have also felt social pressures from others when completing the survey and not answered the survey honestly.

When analyzing some of the data, it was recognized that the session questions collected online using Qualtrics differed in some of the questions from the paper copies that were generated as a backup in case some students were not able to access Qualtrics. The electronic versions of questions four and five in Qualtrics were different from the questions four and five on the paper version because the questions in Qualtrics used sliders that allowed answers from 0 to 100, while the questions on paper used a 5 point Likert scale. Future planning efforts would ensure that this discrepancy is avoided.

Some questions on the surveys were answered more frequently than other questions. This required greater care in comparing results between questions and between surveys.

Chapter 4

Data Collection and Reports

The purpose of the iSTEM conference was to engage pre-service teachers in STEM through hands-on workshops and experiences to build a STEM skill set, and to build confidence in their ability to integrate STEM into their own practices. The conference objectives were as follows. iSTEM participants will:

1. learn why STEM integration has become so important.
2. learn how STEM skills can be integrated into their instruction.
3. increase their commitment to integrating STEM into their instruction.
4. increase their confidence for integrating STEM into their instruction.
5. recognize times when they learned something new and significant (a "learning moment"), and will relate learning moments to STEM skills.

Assessments measuring the extent to which each objective was achieved included quantitative and qualitative analysis. Quantitative sliding scales were chosen for questions one through three on the pre- and post-evaluative questionnaires. Qualitative analysis was applied to the short answer responses on the other pre-and post-evaluation questions, the reflective session evaluations, the summative evaluation, and the debriefing sessions. Qualtrics was used to generate quantitative statistics, assess qualitative responses, and generate graphs. Graphpad.com was used to generate paired and unpaired t-tests. The online program, Textfixer (www.textfixer.com) was used to count the frequency of descriptive words. Both quantitative and qualitative analyses were used to detect changes and to determine likely catalysts for the changes. The quantitative data assigned numerical values to changes in familiarity, perception of importance, and confidence in the ability of the participants to integrate STEM in their

classrooms. Qualitative analyses clarified specific differences in the ways participants thought about STEM and the methods by which changes in their thinking occurred.

Data collected from surveys, videos, and conversations were analyzed following the iSTEM conference to determine the extent to which there existed any relationships and significant effects regarding data results and conference objectives. The STEM cohort members worked in pairs to analyze the results of different evaluation instruments, reporting their findings, and conclusions to the cohort. The questionnaires with their aligned objectives were analyzed. Each evaluation document was coded for efficiency. There were four questionnaires analyzed:

- Pre and Post-Conference questionnaires (PQ)
- Results of Session Evaluations (RQ)
- Results of Summative Evaluations (SQ)

In addition, the final debriefing sessions were also evaluated.

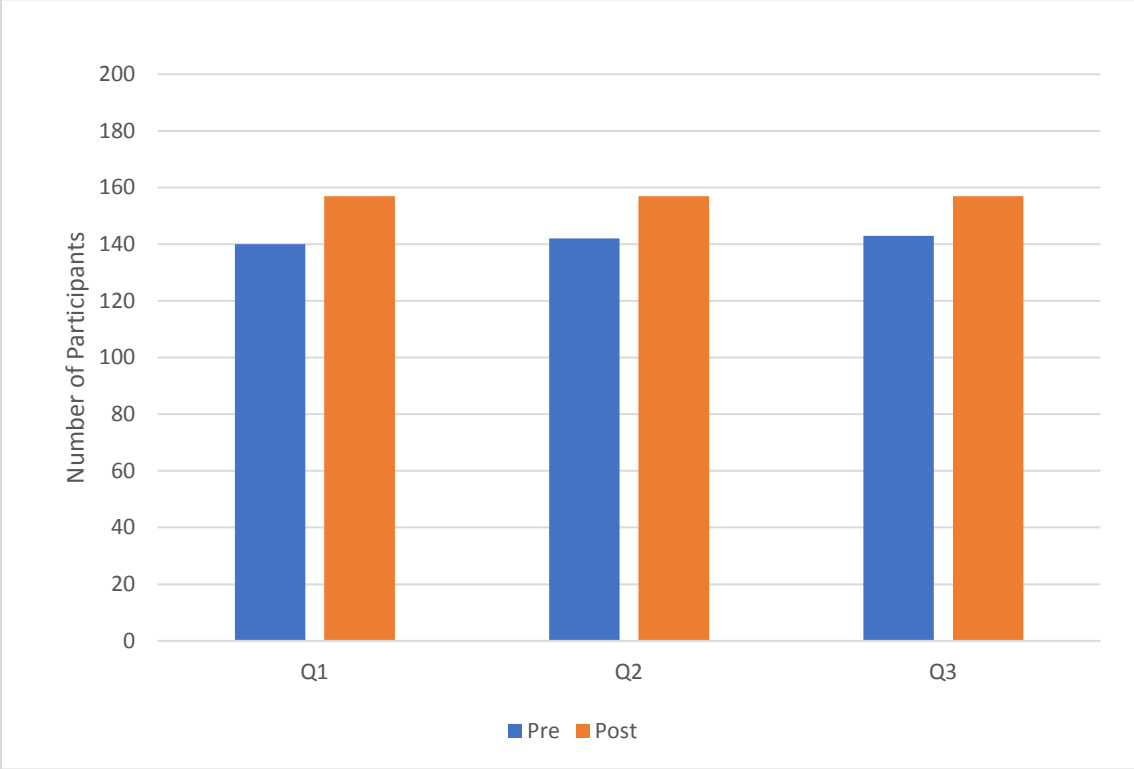
Results and analysis of pre and post conference questionnaires (PQ1-PQ5).

A total of 142 participants responded to the Pre-Evaluative Questionnaire, and 157 participants responded to the Post-Evaluative Questionnaire. The Post-Survey responses reflected an increase in participation of 10.6% from the pre- questionnaire results. The increase in post-responses represents data received from questionnaires that were completed on paper at the conference. Those responses were entered into Qualtrics anonymously so all data could be analyzed in the same manner using Qualtrics tools.

More participants answered the Post-Survey than the Pre-Survey. Figure 2 shows a graph of the number of respondents who answered questions Q1-Q3 on the Pre- and

Post-Surveys. Table 2 gives additional detail on how these questions were answered. Q2 on the Pre-Survey is the same question as Q7 on the Post-Survey which is reflected in Figure 2. When constructing the survey items in Qualtrics, pre-item Q2 was inadvertently moved to post-item Q7 by the software. Q2 on the Pre-Survey and Q7 on the Post-Survey are the exact same question, just with different numbering.

Figure 2
Number of Participants Completing Pre- and Post-Evaluation Questions



Familiarity, Confidence and Integration of STEM Education

PQ1. The results in Table 2 represent an analysis of data collected for the Pre and Post Evaluative Questionnaires as reported by Qualtrics. PQ1: "*My familiarity with STEM education can be best described as* (*0-100, not at all familiar to extremely familiar).*" The first question in the pre- and post-evaluative questionnaires established a

baseline of the pre-service teachers' familiarity with STEM education, and progress towards greater knowledge after the conference. The post evaluative questionnaire was administered to gather responses gauging changes in perception of familiarity with STEM after the conference intervention. This increased knowledge about STEM was related to several of the objectives, many of which require increased familiarity as a prerequisite to progress on other STEM-related goals.

PQ2: *"I am confident I can integrate STEM education in my instruction (0-100 strongly disagree to strongly agree)"*. In the pre-evaluative questionnaire, this question was numbered as Q2. In the post-evaluative questionnaire, it was numbered as Q7. *PQ2* aligns with the objective "*Participants will increase their confidence for integrating STEM into their instruction.***"**

PQ3: *"I believe it is important for me to include STEM education in my instruction (0-100 strongly disagree to strongly agree")* aligns with the objective, *"Participants will learn why STEM integration has become so important."* This question was to ascertain if there was an increase in the number of participants responding affirmatively after the conference intervention.

Table 2
PQ 1, 2, 3 Pre-and Post-Survey Results as Percentages of Familiarity, Confidence, and Integration.

	Pre Conference Survey			Post Conference Survey		
	PQ1: Familiarity (N=140)	PQ2: Confidence (N=142)	PQ3: Integration (N=143)	PQ1: Familiarity (N=157)	PQ2/PQ7: Confidence (N=157)	PQ3: Integration (N=157)
Min. Response	0	0	0	14	19	30
Max. Response	100	100	100	100	100	100
Mean Response	47.8	53.8	72.6	75.1	78.9	88.5
Std. Deviation	27.5	27.3	26.7	19.3	19.4	15.0
Variance	754.9	746.8	710.4	372.4	375.7	224.5
t-values			<0.05			

PQ1. In the pre-conference questionnaires, at least one participant had a response of zero, indicating no familiarity with STEM education. In the post-questionnaires, the minimum familiarity level increased from zero to 14. In the post-conference questionnaires, no one responded as having no familiarity with STEM education

As shown in Table 2, the mean for PQ1, familiarity with STEM, was 47.8 on the pre-survey and 75.1 on the post-survey. There was a change in pre to post mean scores of +27.3, or a 57.1% increase in pre-service teachers indicating more familiarity with

STEM at the end of the conference. There was an increase in the number of participants who understood the nature and purpose of the conference. Table 3 and Figure 2 compare the answers on PQ1 in a different way before and after the conference. In Table 3, there are counts of how many respondents answered in 5 ranges, and percentages for each. Figure 2 shows only the number of responses in for each group of questions, pre-survey and post survey.

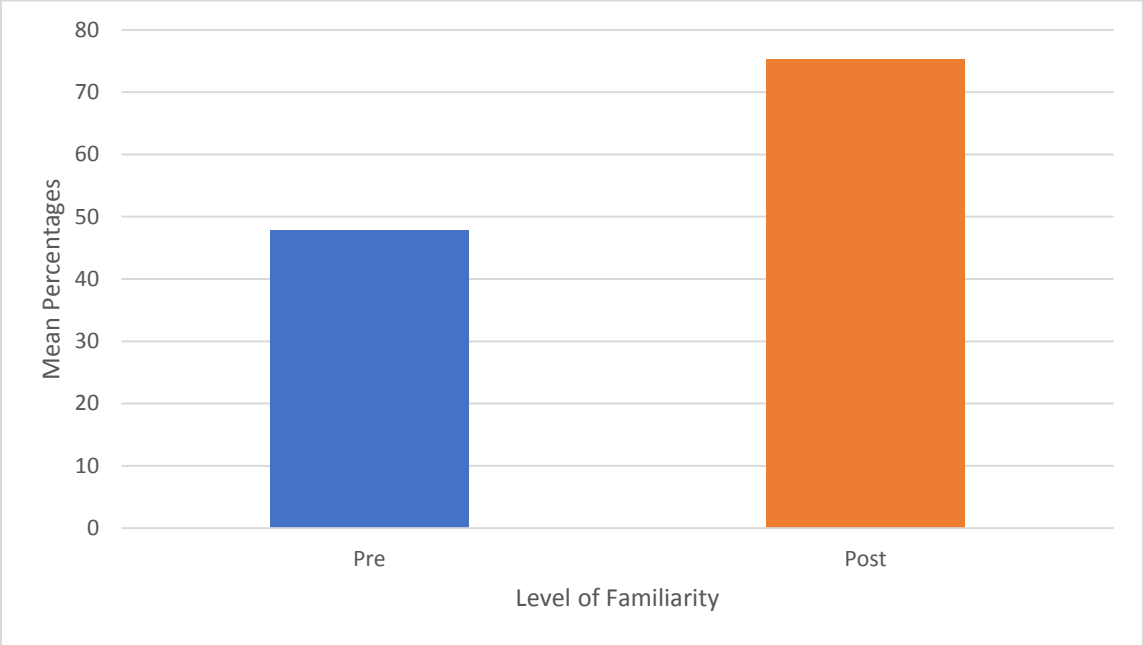
Table 3
PQ1 Level of Familiarity as a percent on a sliding scale

Levels	Levels of Familiarity Grouped	Number of Pre-Responses (N=140)	Percents (%)	Number of Post-Responses (N=157)	Percents (%)
Not Familiar	0	2	1.4	0	0.00
↓	1-25	33	23.6	2	1.3
	26-50	54	38.6	21	13.4
	51-75	25	17.9	51	32.5
Extremely Familiar	76-100	26	18.6	83	52.9

Of the total number of conference participants, 56 individuals used the same email address to complete the pre and post survey, providing an opportunity to compare the changes in their responses. The results from these 56 respondents were analyzed using paired t-test to determine if there was a difference in STEM familiarity, confidence, and beliefs before attending the professional development conference and after attending the conference. Three tools were utilized to complete the paired t-test, including www.mathportal.org, the data analysis tool in Excel, and www.graphpad.com. Each tool provided the same results, indicating there was statistically significant change in pre-and post-results for questions one through three, supporting the conclusion that the

conference made a difference in participants' responses to the questions. Figure 3 shows an increase in how important STEM was perceived by the 56 respondents.

Figure 3
Comparing Means of Expressed Levels of Familiarity for PQ1.



The data in Figure 3 indicate that a majority of the 56 identified conference participants increased their familiarity with STEM education after attending the conference. The average increase for the 56 respondents combined was 32.0 percent. The t-test results showed that there was a significant difference in STEM education familiarity from participants after attending the conference, $t(55)= -8.66$ ($p<0.0001$). Only six of the 56 (10.7%) identified conference participants indicated a decrease in STEM education familiarity after attending the conference.

PQ2. In response to the statement, "*I am confident I can integrate STEM education in my instruction," on a scale of 0-100,* the minimum value indicated in the pre-conference evaluative questionnaires was zero, meaning some participant felt no confidence at all in integrating STEM. The lowest value entered in the post-conference

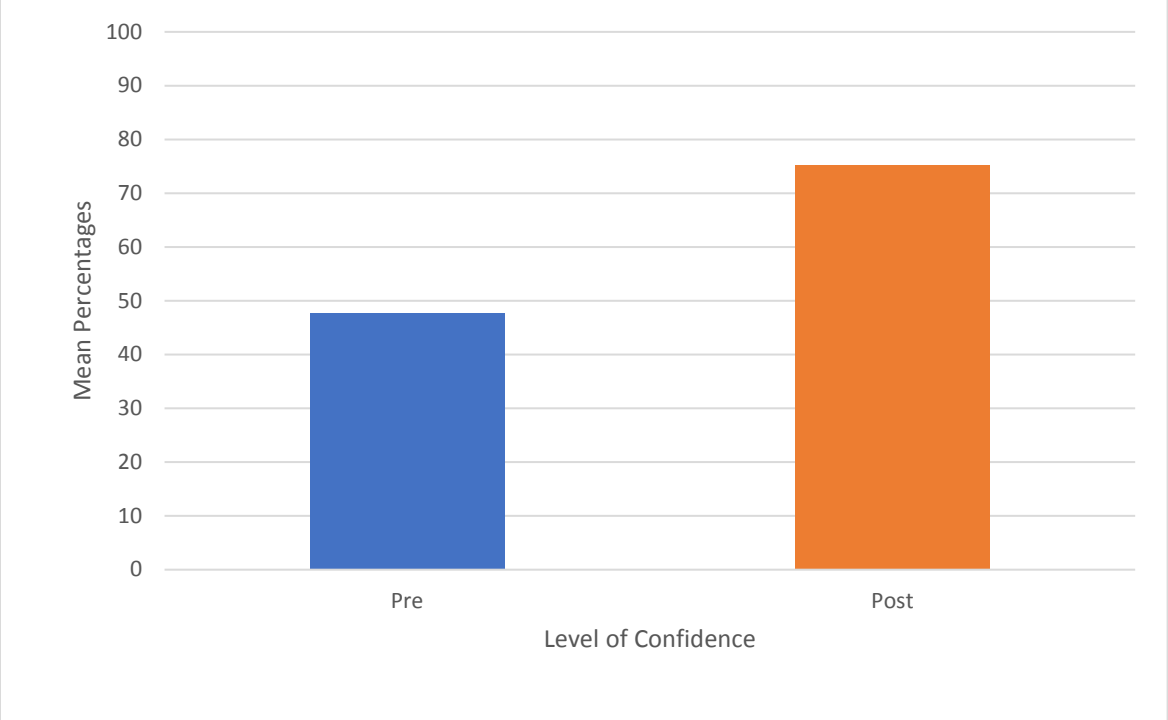
was 19, indicating no participant expressed no confidence in integrating STEM. The maximum values expressed by respondents was 100 in both the pre-and post-evaluative questionnaires, which meant some respondents felt completely confident in integrating STEM education into their instruction. The confidence mean in the pre -conference responses was 53.8 and 78.9 in the post-conference indicating a positive difference of 25.1 or increase of 46.5% (Table 2). Percentage breakdowns for levels of confidence are shown in Table 4. The t-test results showed that there was a significant increase in confidence levels reported by participants after attending the conference, $t(55)= -8.03$ ($p<0.0001$). This result directly addresses the fourth objective.

Table 4
PQ2 Levels of Confidence as a Percentage of Responses

Levels	Levels of Confidence Grouped	Number of Pre-Responses (N=142)	Percents (%)	Number of Post-Responses (M=157)	Percents (%)
Strongly Disagree	0-0	2	1.4	0	0.0
↓	1-25	24	16.9	3	1.9
	26-50	46	32.4	12	7.6
	51-75	36	25.4	47	29.9
Strongly Agree	76-100	34	23.9	95	60.5

Figure 4

PQ2 Comparison of Mean Percentages for Levels of Confidence for Integrating STEM as a Group



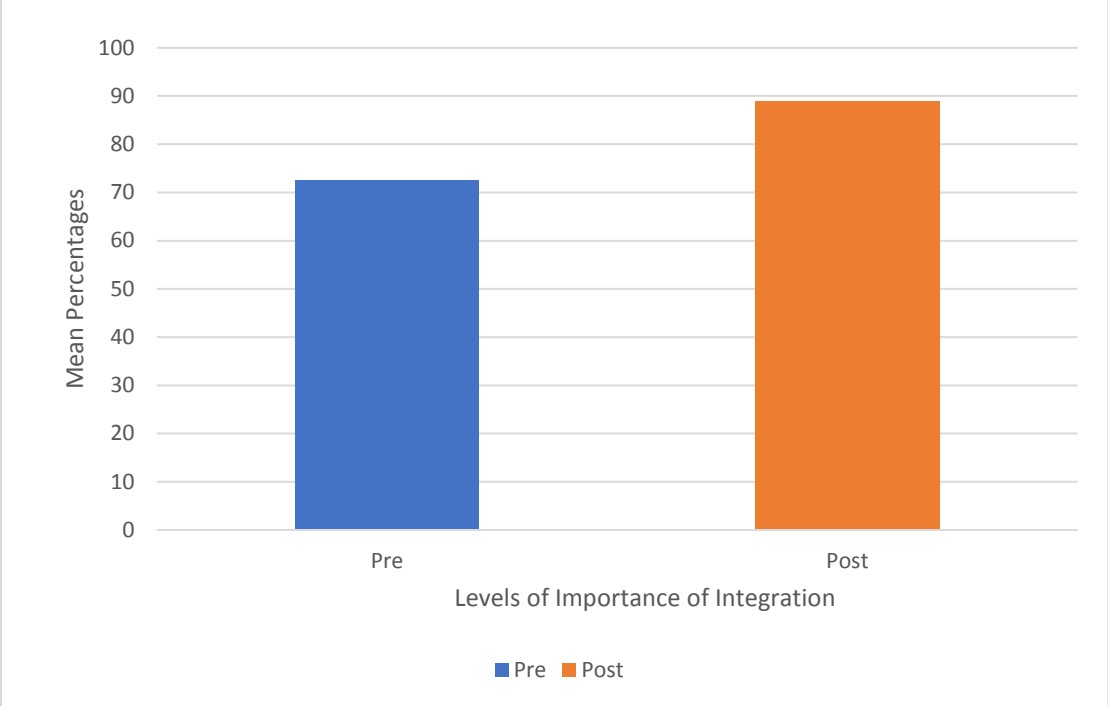
PQ3. In responding to the statement, *"It is important to include STEM education in instruction,"* the pre-conference minimum was 0, meaning at least one participant thought it was not important to integrate STEM education. In the post-conference response, everyone thought STEM education had some degree of importance, which was shown by the minimum value of 30. The maximum values reported in the pre and post evaluative questionnaires was 100, which means before and after the conference some participants thought STEM education was vitally important. Table 5 displays the continuum of perceived levels of importance.

Table 5
PQ3 Perceived Levels of Importance

Levels	Levels of Confidence Grouped	Number of Pre-Responses (N=142)	Percents (%)	Number of Post-Responses (M=157)	Percents (%)
Strongly Disagree	0-0	2	1.4	0	0.0
↓	1-25	10	7.0	0	0.0
	26-50	19	13.3	7	4.5
	51-75	36	25.2	21	13.4
Strongly Agree	76-100	76	53.1	129	83.8

The mean expressed for PQ3 in the pre-evaluative questionnaire was 72.6, and the post was 88.5, showing an increase of 15.9 or 22.0%. This indicated an increase in the number of participants who believed STEM is important to include in instruction.

Figure 5
PQ3 Comparison of Mean Percentages for Levels of Importance for Integrating STEM Education into instruction



The count of participants responding to this question on the pre-conference evaluative questionnaire was 143. The count of participants responding to the post-conference evaluative questionnaire was 157, showing an increase of 14 or 9.8%. The majority of the 56 paired conference participants felt it was important to include STEM education in their instruction both before and after attending the conference. Six of the 56 identified conference participants indicated a decrease in belief that they should integrate STEM education into their instruction after attending the conference. The breakdowns are shown in Table 6.

An unpaired t-test generated a p-value of less than 0.0001, $t(55)=-5.47$ $p<0.0001$, which is considered to be statistically significant, and it implies a major impact on the participants in terms of familiarity, confidence, and ability to integrate STEM education into their instruction.

Defining STEM as a Pre-Service Teacher

PQ4. The question in the pre- and post-evaluative questionnaires "*I define STEM as…*" helped confirm that there was a significant increase in familiarity. The post-evaluative questionnaire was planned to gather responses measuring changes in the pre-service teachers' definition of STEM after the conference intervention and to provide a window of understanding into their perceptions of STEM.

The PQ4 responses received from the pre-service teacher participants were coded for themes, and nine categories were identified. Pre- and post- data was collected to observe change in the responses after the intervention of participating in the iSTEM

Conference. The categories and results associated with those categories are shown in Table 6.

Table 6
Conference Theme Responses and Percentage of Words Describing STEM

Categories	Pre-Conference Theme Response (N=119)	Pre-Conference Theme Response Percentage (%)	Post-Conference Theme Response (N=145)	Post-Conference Theme Response Percentage (%)
Unsure/No answer/Vague	3	2.5	5	3.4
Real-World	9	7.6	10	6.9
Science/Technology/Engineering/Math	74	62.2	66	45.5
Hands-on Learning/Critical Thinking	10	8.4	14	9.7
Interdisciplinary Collaboration	16	13.5	36	24.8
Single-subject	3	2.5	3	2.1
STE(Art)M	3	2.5	0	0
Understanding Principles and Relationships	1	0.8	4	2.8
Mindset/Engaged Minds	0	0	7	4.8
Totals	119	100%	145	100%

Table 6 shows several trends. First, the percentage of responses in the category "Science/Technology/Engineering/Math" decreased from 62.2% to 45.5%. There were also declines in "Real Word," "STE(Art)M," and "Single-subject." The category "Interdisciplinary Collaboration increased from 13.5% to 24.8%. There were also increases in "Unsure/No answer/Vague," "Hands-on Learning/Critical Thinking,"

Understanding Principles and Relationships," and "Mindset/Engaged Minds." In the post-evaluations, a response of mindset was recorded by seven participants, but had not been mentioned in the pre-evaluative questionnaires.

In addition to the analysis using themes, another way to explore the results of PQ4 was to examine word frequencies in the responses. Table 7 shows the results from the computer program, Text Fixer, which counted all the words from responses for PQ4 and identified how many times they were used within the text (frequency) without coding for context, unlike Table 6 which contextualized words within questions and answers for qualitative analysis, Table 7 analyzes frequency. Table 7 contrasts the frequency of keywords before and after the conference.

Table 7
PQ4 - Pre-and Post-Conference Word Frequency for the top 10 Words in the Pre Test

Primary Keywords	Pre Conference Word Frequency (N=982)	Percentage of Primary Words (%)	Post Conference Word Frequency (N=460)	Percentage of Primary Words (%)
Science	224	22.8	108	23.5
Math/Mathematics	220	22.4	100	21.7
Technology	200	20.4	102	22.2
Engineering	198	20.2	93	20.2
STEM	36	3.7	6	1.3
Education	30	3.1	7	1.5
Integrating/Integration/Incorporating	22	2.2	22	4.8
Learning	22	2.2	9	2.0
Hands (on)	16	1.6	7	1.5
Students	14	1.4	6	1.3

One of the objectives of the evaluations was to gauge the change in awareness of STEM during the course of the conference. Question PQ4 asked participants to state their definition of STEM. The word frequency count was used to provide a picture of the various word-based conceptions the pre-service teachers held about STEM before and after the conference. The frequency word count measured divergent and unanticipated answers. The responses for the pre and post evaluative questionnaires were entered separately in the Text Fixer tool, which analyzed the number of primary keywords and

their frequency. The ten most frequent words were used to create graphs of the pre and post data found in Table 7.

The number of words used in the pretest were more than four times the number of words used in the post test. The pretest was given online before the conference began; the post test was administered after the conference, on site, just before participants left. Respondents may have been less verbose than when they filled out the answers in the pretest.

The terms Science, Technology, Engineering, and Mathematics and education had similar pre and post responses in terms of percentage, and were the highest in both. The responses of integration remained the same, and learning and hands-on had similarly proportionate decreases in reported post conference data. Little mention was made of related concepts such as inquiry, investigation, or problem-based learning.

PQ5. The question, *"I can integrate STEM education in my instruction in the following ways",* is aligned to the conference objective, *"Participants will learn how STEM skills can be integrated into their instruction."* Analysis of the content was achieved by coding common themes and patterns. The final codes were categorized into six groups consisting of: unsure, real-world, technology, hands-on, interdisciplinary, and words associated with the 4 C's of STEM education, which were previously described in Chapters 1 and 2. The keywords in Table 8 were used most frequently by the pre-service teachers and pointed to their understanding of how they could integrate STEM education into their own instruction. Between the pre- and post-surveys, "Unsure" dropped from 20.2% to 1.0%. "Real World" and "Interdisciplinary" also dropped. "Technology" increased from 17.0% to 43.0%. "Hands-On" and "4 C's" also increased.

Table 8
PQ5 Ways Participants Plan to Integrate STEM in Their Instruction

Categories	Pre N=94	Percentages (%)	Post N=100	Percentages (%)
Unsure	19	20.2	1	1.0
Real World	13	13.8	6	6.0
Technology	16	17.0	43	43.0
Hands on	8	8.5	13	13.0
Interdisciplinary	31	33.0	19	19.0
4C's	7	7.5	18	18.0

As initial themes were identified, it was noted that each category included other key words or phrases that were of similar meaning and, therefore, were coded into one of the main categories. The key words and/or phrases that were combined to form each category are displayed in Table 9.

Table 9
Categories for Key Words Describing STEM Integration

Categories	**Synonyms**
Unsure	No Answer I Don't Know N/A Still Processing
Real World	Authentic Real Life Relatable
Technology	Apps Chromebooks Virtual Naming a specific game/application
Hands on	(no other key words or phrases included in the category)
Interdisciplinary	Integrate Incorporate Cross-Curricular
4 C's	Collaboration Critical Thinking Communication Creativity

The pre and post survey Question PQ5 was closely checked for accuracy of keyword and phrase counts. Not every answer was a meaningful response; therefore, through the

process of data reduction, some answers did not fit into any category and were not counted.

To strengthen the validity of the coding process, a secondary method was utilized to count key words. The biggest limitation for Text Fixer was that it did not allow the user to combine words into phrases such as “real-world.” Text Fixer counted real and world separately, so it was difficult to compare the use of key phrases to that of the initial coding process. Additionally, if words were spelled incorrectly, they would be listed separately, so they may not be counted unless the researcher identified what the misspelling was. For example, “integrating” was used seven times, and “intergrating” was used two times.

Key phrases that were categorized with single keywords cannot be identified using Text Fixer, so the tool may not be as useful as originally thought. Identifying individual words did not allow the words to be put into a context and, therefore, could not be analyzed appropriately.

Results of Text Fixer for PQ5. The final codes were categorized into six groups consisting - unsure, real-world, technology, hands-on, interdisciplinary, and words associated with the 4 c’s of STEM education. The keywords in Table 8 were used most frequently by the pre-service teachers and indicated their understanding of how they can integrate STEM education into their own instruction. While identifying initial themes, keywords or phrases that were of similar meaning were coded together into one of the main categories. The key words and/or phrases that were combined to form each category are listed in Table 9.

Results and analysis of session evaluations

RQ1. The first question on the session evaluations, "*What did you learn in this session that you would integrate in your instruction?"* was aligned to the conference objective, "*Participants will learn how STEM skills can be integrated into their instruction"*. The purpose of this question was to see if participants had learned strategies or ways to integrate STEM into their teaching. It was open ended to generate a variety of responses and it produced a large amount of data. The data from all 20 sessions were combined using the Text Fixer and a frequency word count was created. In constructing the frequency list, responses were entered separately in the Text Fixer tool, which identified how many times words were used within the text (frequency) without coding for context. From that, themes were generated, and totals and percentages were tallied. Table 10 shows the percentages of responses that fell within the categories. Many participants reported that their instruction would include technology and various STEM activities. Sixty eight participants who used paper surveys yielded 245 responses to this survey item.

Table 10
RQ1 Selected Learning Strategies from 245 Respondants Regarding Integration of STEM

Themes	Proportions (%)
Instruction	27.0
Technology	28.0
Activity	21.0
Engagement	1.0
Other	12.0
Knowledge of students	6.0
problem-solve	3.0
games	3.0

N=801

RQ2. The question, "*Which of the following strategies contributed to your learning (check all that apply: Direct Instruction, Observation, Exploration, Collaboration, and Other)?"* was aligned to the conference objective, *"Participants will recognize times when they learned something new and significant (a "learning moment"), and will relate learning moments to STEM skills."* Respondents were able to select or write in all the different types of strategies they experienced in the session. Based on the results, (Table 11) "exploration" was the top category participants identified that contributed to their learning in the sessions**.**

Table 11
Identification of Learning Moments

Learning strategy	Number of Responses identifying each methods (N = 934)	Percent (%)
Observation	166	17.8
Direct instruction	227	24.3
Collaboration	239	25.6
Exploration	286	30.6
Other	16	1.7

RQ3. The question, *In which of these "four C's" were you engaged during this session? (check all that apply: communication, critical thinking, collaboration, creativity),* is aligned to the conference objective, *Participants will recognize times when they learned something new and significant (a "learning moment"), and will relate learning moments to STEM skills.*. Respondents identified strategies by which they learned within their sessions that could also help them develop STEM skills in their students. The top "four C" reported was "Creativity", followed by "Collaboration", "Critical Thinking", and then "Communication." Table 12 illustrates the comparative frequencies of those expressions.

Table 12
Recognition of the 4 C's in iSTEM Sessions responses to RQ3

Learning strategy Recognized	Total (N=547)	Percent
Communication	106	19.3
Critical Thinking	137	25.0
Collaboration	155	28.3
Creativity	149	27.2

RQ4. Participants responded to the statement, "*This session enhanced your confidence to provide STEM instruction"* which is aligned to the conference objective, "Participants will increase their confidence for integrating STEM into their instruction". Respondents were able to select a numeric response from 0 to 100. The responses collected electronically were compiled in Table 13. Each row represents one session, and one session did not turn in any surveys. Since each participant could attend two sessions, the number of responses is more than the number of participants. Participants attended concurrent sessions so the responses are combined for 10 concurrent session. Each row summarizes the results of one session. Qualtrics did not register data for the session marked N/A. Therefore, only the mean and the count appear on this row.

Table 13
RQ4 Responses for Confidence in Providing STEM Instruction

Session	Minimum	Maximum	Mean	Count
1	70	100	87.4	24
2	27	100	81.7	27
3	50	100	80.6	17
4	20	100	86.9	18
5	10	100	76.9	50
6	16	100	82.9	14
7	0	100	64.7	12
8	100	100	100	2
9	24	100	73.8	8
10	70	100	87.4	11
11	20	100	78.9	17
12	2	100	54.6	13
13	10	100	83.9	69
14	50	90	73.3	3
15	50	100	88.2	34
16	50	89	69.5	2
17	20	100	80.4	8
18	80	100	96.0	9
19	N/A	N/A	87.6	11
			Totals	349
			Overall Mean	81.5

During the sessions, 68 participants responded to the survey questions on paper instead of electronically. Their responses were collected using a Likert scale, in which respondents could select from the following: “Strongly Disagree, Disagree, Uncertain, Agree, or Strongly Disagree” to indicate that the session enhanced their confidence to

provide STEM instruction. Of the responses collected, fifty-three (77.9%) agreed with the statement that the session enhanced their confidence in providing STEM instruction as shown in Table 14 in which twelve (17.7%) disagreed, and three (4.4%) were uncertain.

Table 14
RQ4 Enhanced confidence for providing STEM instruction (paper responses)

Levels	Number of Responses N=68	Percentage of Responses (%)
Strongly Disagree	7	10.3
Disagree	5	7.4
Uncertain	3	4.4
Agree	30	44.1
Strongly Agree	23	33.8
Average Mean	81.6	

Table 15

RQ4: Participants' Reported Likelihood of Applying the Instructional Ideas

Session	Minimum	Maximum	Mean	Count
1	72	100	93.5	24
2	0	100	78.7	27
3	9	100	84.3	17
4	70	100	91.9	18
5	10	100	85.0	50
6	41	100	92.0	14
7	0	100	68.7	12
8	100	100	100	2
9	50	100	83.5	8
10	67	100	88.6	11
11	70	100	89.2	11
12	10	100	82.6	17
13	1	100	62.9	12
14	2	100	89.3	68
15	50	100	78.3	3
16	40	100	92.2	34
17	50	100	75.0	2
18	77	100	93.1	8
19	87	100	97.7	9
			Total	347
			Overall Mean	86.6

RQ5. Responding to the prompt, "*I am likely to use the instructional ideas from this session with my students,"* participants reported levels of commitment toward integrating their newly learned STEM instructional ideas. This question is related to the goal, "Participants will increase their commitment to integrating STEM into their

instruction." The responses collected electronically are represented in Table 16. Each row summarizes the results from one session.

From the additional 68 surveys collected on paper, Table 16 shows that 56 (82.4%) of the respondents agreed or strongly agreed, while only seven (10.3%) disagreed or strongly disagreed.

Table 16
RQ5: Participants' Reported Likelihood of Applying the Instructional Ideas (paper responses)

Levels	Number of Responses N=68	Percentage of Responses (%)
Strongly Disagree	5	7.4
Disagree	2	2.9
Uncertain	5	7.4
Agree	22	32.4
Strongly Agree	34	50.0
Average Mean	86.6	

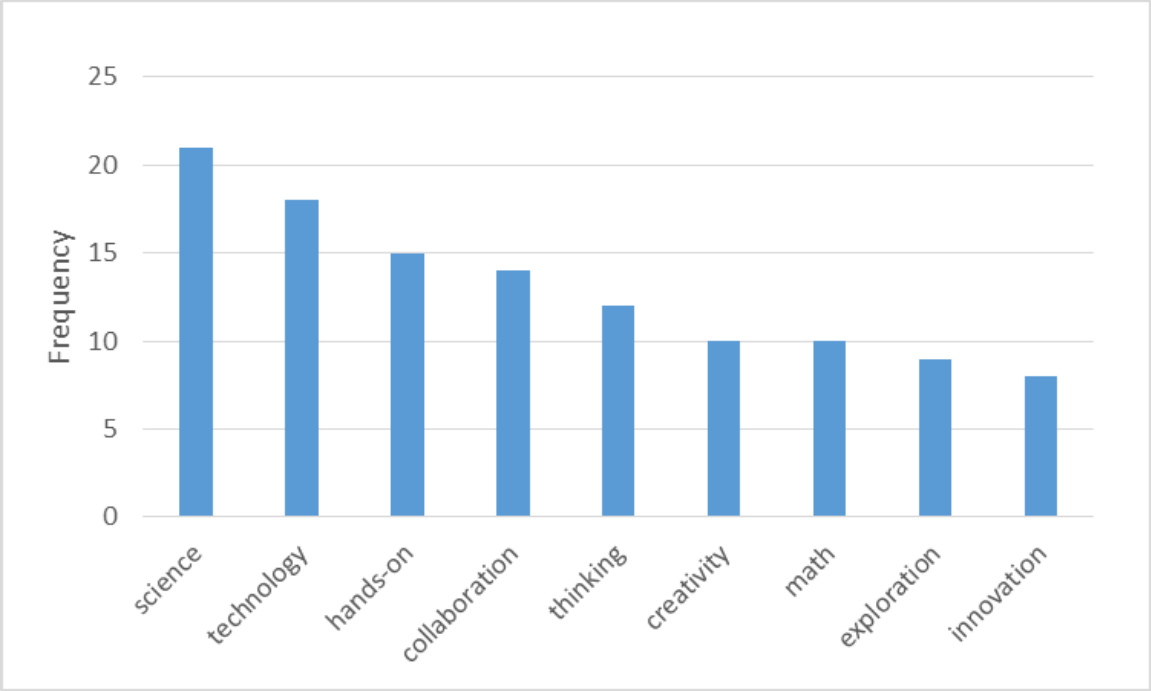
Results and analysis multimedia and Wordle

The following Wordle (Figure 8) was generated from participant responses to the prompt, "Write 3 words that you think of when you think of STEM?"

Figure 6
iSTEM Wordle displaying results of respondents submitting 3 words about STEM

Ninety-three participants submitted responses to the Wordle prompt. A total of 292 words or phrases were recorded. Of the 292 words submitted, there were 156 unique terms. Figure 9 displays the top nine most frequent terms that were submitted. Science, technology, and mathematics were identified in the first nine; “engineering” did not. The term “engineering” garnered the same number of responses as the word “fun.” Seven terms appeared six times; four terms appeared four times; eight terms appeared three times; nineteen terms appeared twice; and one hundred eight terms appeared only once. As the cards containing the three words about STEM were collected, it was noted there were commonalities in the word choices of participants sitting together.

Figure 7
Top Nine Words from Wordle



The words that were submitted through the participant response session were also clustered using an open coding system. The words and phrases were organized according to similarities and meanings. Several categories were chosen to contain the words based on the responses. The 4-Cs (Collaboration, Creativity, Critical Thinking, and Communication) was a natural code heading as one of the objectives upon which the iSTEM conference was organized. Another code heading, Qualifying Descriptor, was used to represent words or phrases that described some aspect of the conference or provided some insight into how participants felt about the conference. Terms such as "hard, influential, and memorable," described how some participants felt about the conference. Other examples of codes used were "hipster," a term used in common vernacular to describe some aspect of the iSTEM conference. Hipster language also provided information to correlate the demographics of some of the participants. "Science,

Technology, Engineering, and Mathematics" were obvious code headings since these words embodied the iSTEM conference.

Results and analysis of summative evaluation

A summative evaluation instrument was administered at the end of the conference and was designed to measure the overall effectiveness of the conference, give participants an opportunity to reflect on their learning, and detail how the iSTEM conference experience might impact participants. For example, to what degree did participants plan to incorporate elements of the conference into their future projects, such as the SAIL projects mentioned earlier? The premise of the questionnaire was to identify moments of impact that positively shifted attitudes toward STEM.

SQ1. The question, "*Why has STEM integration become so important?"* aligns to the conference objective, "*Participants will learn why STEM integration has become so important."* The question was intended to assess whether attendees understood the importance of STEM integration and its potential impact on society. Two response categories were used to organize the collected responses: teacher performance and career readiness. The first category included responses related to the integration of STEM into the classroom, and the second included responses on developing STEM skills related to the 4 C's for 21st Century STEM careers.

The Teacher Performance category was divided into four sub-groups labeled teaching, evaluation, integration, and student learning, as shown in Table17. Responses coded under "teaching" focused on the teacher and his or her practice. Here, the importance of integration is that it is used by the teacher to improve his or her

instructional effectiveness. The theme "evaluation" reflected the impact that STEM integration might have on assessments. Responses coded under "integration" highlighted cross-curricular relationships among and between STEM and non-STEM subjects. The "student learning" code focused on the effect of STEM integration on student learning outcomes. Under the category of Career Readiness there were three sub-groups labeled: skills, knowledge, and practice. *Skills* referred to comments on a student's propensity to perform a STEM related job or task. Information coded under *knowledge* was linked to the understanding about the differentiation between and among STEM careers. *Practice* denotes statements that mentioned actions that students could be taking *now* to prepare for STEM careers in the future. Any statement that did not address the objective was coded under the heading *Blanket Statement*. Table 17 illustrates the percentages for each area of importance.

Table 17
SQ1 Expressed Area of Importance for STEM Integration

Category	Area of Impact	Count (N = 182)	% Responses
Teacher Performance	Teaching	22	12.1
	Evaluation	3	1.7
	Integration	9	4.9
	Student Learning	51	28.0
Career Readiness	Skills	34	18.7
	Knowledge	33	18.1
	Practice	5	2.8
Blanket Statements	OPEN	25	13.7

There were 182 responses coded for Q1 of the summative evaluation. The results indicate that 28% of the attendees believed that STEM integration is important because of the impact it has on student learning; 12.1% mentioned the impact STEM integration has on improving teaching practices. With respect to developing STEM skills, 18.7% of the pre-service teachers indicated that the education of students has the greatest impact on understanding or gaining understanding about STEM. Under career readiness, 18.1% of the responses focused on equipping students with the knowledge they need to secure a job in a STEM based field. Another 4.9% of the participants felt that integration was important in the preparation of students for STEM based careers.

SQ2. The question, "*Based on this conference, name ways how STEM education can be integrated in your instruction,"* aligns to the conference objective, "*Participants will learn how STEM skills can be integrated into their instruction."* The question

assessed whether the attendee understood how to integrate STEM skills into their instruction. The collected responses were categorized into four groups: instruction, strategies, technology, and open comment as shown in Table 18. Under the categories of instruction and technology, two subgroups were formed - one for student based responses and one for teacher based responses.

Instruction includes learning activities. For example, if the participant mentioned *using project-based learning*, the response was coded under *instruction, student learning*, because the focus was the student performance and the overall goal was to affect student learning. The comment, "*I am going to align my science and math lessons*," was coded as instruction-teaching because the focus is on providing better instruction. *Strategy-learning* were comments that spoke to physical changes such as moving to small group, team-teaching, and collaborations with outside agencies. *Technology* highlighted any mention of integrating computer devices, games, apps, or maker-spaces. The technology tag was further divided into teacher/student, depending on who would primarily be using the technology. *Open comments* did not provide enough information to place them into a category but represent a significant proportion of the responses as shown in Table 18.

Table 18
SQ2: Integrating STEM into Instruction

Category	Sub-category	Count (N=148)	% Responses for Integrating
Instruction	Teaching	33	22.3
	Student Learning	18	12.2
Strategies	Learning	5	3.4
Technology	Student	23	15.5
	Teachers	28	18.9
Open Comment	Open Statement	41	27.7

Of the total responses received for SQ2, 41.2% focused on the teacher with 22.3% for instructional integration, and 18.9% for technology integration. Looking across categories, student centered comments accounted for 27.7% of the responses with 12.2% being instructional integration and 15.5% being technology integration. Thirty-four and five tenths percent of pre-service teachers said STEM integration would happen through learning activities. Open statements made up 27.7% of the responses. These statements varied in content, and did not directly address the question.

SQ3 A-G. The prompt, "*Indicate to what degree each of these contributed to your learning: keynote speaker, presentation content, working collaboratively in sessions, opportunities to reflect, active participation within sessions, discussions within sessions, discussions outside of sessions, and other,"* aligns to the objective: *"Participants will increase their confidence for integrating STEM into their instruction."* .as well as the objective *"Participants will recognize times when they learned something new and significant (a "learning moment"), and will relate learning moments to STEM skills."*

Participants rated the degree to which an individual aspect of the iSTEM Conference contributed to their learning. There were seven strands to be measured including: keynote, presentation content, collaboration within sessions, reflection opportunities, active participation within each session, and discussions both inside and outside of the sessions. Core features of professional development activities include:

> (a) the degree to which the activity has a content focus, that is, the degree to which the activity is focused on improving and deepening knowledge in STEM;
>
> (b) the extent to which the activity offers opportunities for active learning, such as opportunities for teachers to become actively engaged in the meaningful analysis of teaching and learning; and
>
> (c) the degree to which the activity promotes coherence in professional development, by incorporating experiences that are consistent with teacher goals and aligned with state standards and assessments, and by encouraging continuing professional communication among teachers (Garet et.al, 2001, p.920).

One hundred thirty-four participants answered summative SQ3 online and 22 participants used a paper version of the survey. SQ3 asked participants to indicate to what degree specific aspects of the conference contributed to their learning. A key feature of this question was the addition of a 0 to 100 sliding scale. The rating system allowed users to quantify their learning with 0 being not at all and 100 being transformational. To develop equivalency between the two surveys, grades were given to each of the categories on the paper/pencil survey – similar to an academic grading scale, as shown in Table 19. One item was randomly selected then tested to compare averages. The impact rating is a determination of the influence the conference event had on a participant's learning. The

average impact rating for the online survey was 80.6 and the paper/pencil survey averaged 82.0. It was determined that using the grade scale was an acceptable way to measure responses on the paper/pencil tests. The means from the web-based surveys were averaged with the paper/pencil surveys to create one master set of data for SQ3.

Table 19
Developing Equivalency between Qualtrics and Pencil Questionnaires

Choice	Academic Grade /Evaluation Description	Quality Equivalent
A	Failing/Not at All	0
B	Poor/Slightly	69
C	Average/Somewhat	79
D	Above Average	89
E	Excellent/Extremely	100

Respondents recorded “active participation within sessions” as an impact rating of 86.3% and “discussions outside of the sessions” as a 78.7% (See Table 20). These results support the iSTEM foundation of active learning. The presentation content and active presentation are the two strands that did not have a minimum score of zero. “Discussions outside of sessions” was the only category to not receive a maximum score of 100.

Table 20
Key Program Elements of Learning (N=156)

Field	Minimum	Maximum	Mean
Keynote Speaker	0.0	100.0	81.3
Presentation Content	69.0	100.0	83.2
Working Collaboratively in Sessions	0.0	100.0	82.5
Having Opportunities to Reflect	0.0	100.0	81.2
Active Participation within the Sessions	69.0	100.0	86.3
Discussion with the Sessions	0.0	100.0	82.5
Discussions Outside the Sessions	0.0	89.0	78.7

SQ3H. The question, *What other aspects of this conference contributed to your learning?,* was aligned to the conference objective, *Participants will increase their confidence for integrating STEM into their instruction.*. This question assessed the attendee confidence in integrating STEM skills into their classroom, based on their newly found understanding. The collected responses were categorized into seven sub-groups under two categories which were materials and blanket statements. Materials refer to the different components of the actual conference itself. Categories in Table 21 are:

- *Resources* - Items given out in the sessions such as apps, educational platforms, strategies used during the presentation such as having the attendees working in small groups, rotations, etc.;
- *Information* refers to the STEM-based concepts discussed during the sessions, or the historical breakdown shared in the opening session done by the advisor / panel;

- *Presentation* refers to the attitude or demeanor of the presenters and their ability to connect with the attendees and get them involved in the sessions;
- *All* refers to the comments about the entire conference;
- *Keynote* are comments related to our guest speaker and her presentation;
- *Debriefing* refers to the sessions that happened at the end where the pre-service teachers were given an opportunity to discuss their experience with peers and reflect; and
- *Open* statements are those statements that did not address the objective.

Table 21
Other Aspects of Conference Contributing to Learning

Component Category	Count	Degree of Contribution in %
Resources	24	17.6
Information	20	14.7
Presentation	31	22.8
All	22	16.2
Keynote	7	5.1
Debriefing	24	17.6
Open Statement	8	5.9

The attitude of the presenter was named as an inspiration for learning in 22.8% of the responses. The ease of the delivery of the materials and information aided the pre-service teachers in gaining understanding. Attendees stated that it was "easy to ask different questions of the presenters," and that being able to ask helped them get clarity when they did not quite understand. The debriefing session and the conversations that ensued were invaluable to the pre-service teachers, with 17.6% saying that these sessions

helped to bring things together and provided time to again reflect and ask questions. Another 17.6% of the attendees felt that the session resources added to the learning more than the information or topic of the session. Only 14.7 % of the pre-service teacher felt that the information furthered their learning. The relative uniformity of most of the categories is observable in Table 21.

SQ4. The question, *What do you feel is needed to sustain what you learned in your sessions?,* was intended to assess if the attendee understood how to integrate STEM skills into their classroom, and be consistent in the practice. The responses were placed into three groups: external, internal and open comment under one category called sustaining factors (Table 22). The external factors identified people, places, and options that were outside of the respondent such as the school district, my principal, my instructor, and professional development. Internal factors represented answers that were directly related to the respondent themselves and options they would choose such as take more classes, practice with a co-worker, and developing more lessons. The final category of open statements included responses that did not address the question that was asked.

Table 22
Perceived Sustainability of Learning (N=126)

Sustaining Factors	Count	%
External	68	54.0
Internal	50	39.7
Open statement	8	6.3

SQ5. The question, *How essential do you feel conferences like this are to your teacher development?* was designed to measure the effectiveness of the conference as it was perceived by the participants. As described in SQ3, equivalency table - Table 19, *Developing Equivalency Between Qualtrics and Pencil Questionnaires,* a grading system

was used to convert the paper/pencil surveys into useable data as per Table 20. As shown in Table 23 the conference yielded an overall approval rating of 80.45 out of 100. The minimum was zero and the maximum was 100. Most respondents believed the iSTEM conference was either *very* or *extremely* essential to their teacher development.

Table 23
Conference Importance to Teacher Development

Range	Mean	Count
0-100	80.45	155

Results and analysis of debriefing sessions

When participants were initially asked what they wanted to discuss near the end of the conference day, most of their responses summarized what they liked best about the conference. Key words and phrases included: *choice in sessions, relevance (content specific and timely), engagement, active participation, hands-on, no lecture, building STEM thought-processes into classroom, fun photos of learning moments, energizing, enthusiasm,* and *emphasis on implementation.* Concerns included: lack of STEAM (arts integration), fitting STEM into already compact curriculum, and disappointment there was not time to attend more of the sessions. A physical education pre-service teacher was disappointed the sessions did not seem to relate directly to his content. A social studies pre-service teacher expressed a similar sentiment, as did a foreign language candidate. These comments matched the findings by Goerkmenoglu, T., & Clark, T. (2015) that teachers want to learn about how practices and ideas connect with their own content. In other groups, participants mentioned it would be more helpful to have specific grade-

level content. One participant suggested that the STEMES cohort survey participants during registration to identify specific areas of interest.

Participants were asked about their "ah-ha" moments and what they would like to try to teach. Many responded by describing some of the educational apps they learned about, including learning games, electronic assessment, and virtual field trips. Favorite learning activities included *Barbie Bungie Jump, gallery walks* and other out-of-seat learning strategies. Several mentioned interdisciplinary activities and that they were more interested in STEM after the conference than they were before the conference. Much of the enthusiasm seemed to be generated by learning enjoyable and creative ways to engage students in learning. Many participants identified connections to their particular content. An ELA pre-teacher noted that STEM information is often overlooked in content. The participant commented that "it would be fairly easy to bring STEM concepts into focus without changing learning materials."

Chapter 5

Conclusions

The iSTEM 2017 conference was designed to acquaint pre-service teachers with interdisciplinary, research-based STEM instructional strategies to transform traditional classroom pedagogy into dynamic learning environments. The main inquiry questions throughout the planning process were: *"What forms of engagement are most useful to pre-service teachers?"* and, *"How do professional development facilitators create experiences that result in impactful learning?"* Exploration and research in student engagement and conference design principles led the STEMES Community of Practice to the conclusion that iSTEM 2017 should be guided by Barkley's (2009) framework for meaningful engagement and a combination of constructivist and gamification principles. Utilizing these principles, iSTEM 2017 was intended to specifically convey the importance of integrating STEM into the classroom, demonstrate how STEM skills can be integrated into interdisciplinary instruction, and increase the commitment and confidence level of pre-service teachers for integrating STEM into their own instruction.

Findings suggest that the iSTEM 2017 conference made an overall positive impact on pre-service teachers' familiarity with STEM education, on their belief in the importance of STEM education, and on their confidence to integrate STEM education into their own instructional practices. These perceptions were based on pre- and post-conference survey results, session evaluations, post-conference debriefing sessions, and analysis of learning moments throughout the conference.

Pre- and Post-Conference Surveys

Of the 284 people who registered for the conference, 143 completed the pre-conference survey before arriving at the conference site, and 157 completed the post-conference survey on site before leaving the conference. Fifty-six conference participants (nearly 20%) identified themselves with an email address on both the pre and post conference survey, and therefore there results could be analyzed using a paired *t*-test. The remaining surveys were analyzed using an unpaired *t*-test.

PQ1: Pre and Post Evaluation. This question asked how familiar the participants were with STEM education. The paired *t*-test showed an overall average increase of 32 percent, while the average unpaired *t*-test responses rose from 46 percent to 75 percent. Six of the 56 paired *t*-test respondents (10.7%) indicated a decrease in familiarity with STEM education after attending the conference. We conjecture that a decrease in STEM education familiarity for that small group could be the result of 1) pre-service teachers' not fully understanding what STEM education was before attending the conference, and subsequently realizing after the conference that they knew less than they thought they did, 2) pre-service teachers could not recall how they previously assessed their own STEM education familiarity on the pre-conference survey, and 3) some may have attended sessions that failed to convey an understanding of STEM.

PQ2: Pre and Post Evaluation. Question two asked participants to rate their confidence level in their ability to integrate STEM education into their instruction. Results determined that a large majority of pre-service teachers felt that the conference helped them feel more confident in their ability to integrate STEM education into their instruction. The paired *t*-test showed an overall average increase of 30 percent,

while the average unpaired *t*-test responses rose from 53 percent to 79 percent. Eight of the 56 paired *t*-test respondents (14.3%) indicated a decrease in their confidence level. The average decrease was 10 points, based on a 100-point scale. This slight reduction could be the result of relatively few pre-service teachers feeling overwhelmed with all of the new materials presented to them throughout the day, and they needed more time to reflect on how they could utilize and incorporate this information into their practice. Additionally, pre-service teachers could have forgotten how they previously assessed their confidence level on the pre-conference evaluation, and did not intend to show a decrease in their confidence level.

PQ3: Pre and Post Evaluation. Question three asked participants to indicate how important it was to include STEM education into their instruction. The paired *t*-test showed an overall average increase of 18 percent, while the average unpaired *t*-test responses rose from 72 percent to 89 percent. Six of the 56 paired *t*-test respondents (10.7 %) indicated a decrease in the level of importance of integrating STEM education into their instruction. A decrease in importance level could indicate that pre-service teachers did not gain the necessary skills and/or abilities to integrate STEM education into their instruction, or did not acquire enough confidence to do so. As is the case with questions 1 and 2, conference participants may have forgotten their original indices when evaluating the degree to which they felt it was important to incorporate STEM education into their own instruction. The post conference survey was taken at the end of the day and once submitted, participants were allowed to leave. Some participants may have rushed through the survey in order to leave, and therefore did not contribute the same amount of time and consideration when completing it. Also, not all participants were

exposed to the same interventions sessions and therefore some may have had less than ideal experiences.

PQ4: Pre and Post Evaluation. Question 4 asked participants to define STEM. More than 60% of participants defined STEM as Science, Technology, Engineering, and Math. Although correct in identifying the expanded version of the acronym, the researchers intended for participants to identify a deeper meaning or concept of STEM education, and therefore realized that the question may not have been appropriately asked. After a brief review of what the definition of STEM education was, it was clear that STEM education has a multitude of definitions and meanings and, therefore could be a contributing factor to the uncertain and vague answers. Hom (2014) defines STEM as a curriculum that is based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach based on real-world applications. Fourteen percent of participants identified "interdisciplinary" in their STEM definition, and nearly 8% of participants utilized "real-world" in their definition. There was a 125% increase in the use of "interdisciplinary" on the post evaluation, indicating participants gained a deeper appreciation and understanding of interdisciplinary aspects of STEM education.

PQ5: Pre and Post Evaluation. Question 5 asked participants to identify ways in which they can integrate STEM education into their curriculum. Open coding analysis determined the major themes of both the pre- and post- evaluation to include: emphasis on the four core subjects of STEM, incorporating more hands-on activities through real world applications, and creating interdisciplinary lessons. The post evaluation results indicated a considerable increase in the application of technology- including interactive

games, applications, and tools. Additionally, an increase in the utilization of the four C's (collaboration, creativity, communication, critical thinking), was described in participants' post conference evaluation. The most telling of differences was a decrease in "unsure" responses from the pre and post evaluations. Nineteen participants indicated in the pre evaluation that they were "unsure" of the ways in which they could integrate STEM education into their curriculum, and only one participant indicated "unsure" as a response on the post evaluation.

Whereas the overall pre- and post-conference results were encouraging, other objectives were more difficult to analyze. The STEMES Community of Practice strived to provide opportunities throughout the conference for pre-service teachers to recognize their own learning moments and relate those to STEM skills. Reflective session evaluations asked participants to identify strategies that contributed to their learning. The strategies from which participants could choose included: direct instruction, observation, exploration, and collaboration. As indicated by the reflective session results, 31 percent of participants identified exploration as the most utilized strategy, followed by 26 percent collaboration, 24 percent direct instruction, and 18 percent observation. One percent of participants identified "other" as a learning strategy that was utilized.

To increase the efficacy of evidence supporting the objective of pre-service teachers recognizing their own learning moments, a second question asked participants to identify which of the four C's they were engaged in during each session. Participants responded that all four C's were utilized: communication, critical thinking, collaboration, and creativity. Creativity showed the strongest percentage of engagement. Acknowledgment of the four C's being applied during the sessions also

indicated that pre-service teachers had an understanding of the relevance and meaning of the four C's as related to STEM education. As articulated to the conference participants, the four C's are a set of skills that contribute to students becoming contributing citizens in a 21st century society and are attributed to success in the STEM workforce (Varon, n.d.).

Expressing that these learning strategies were used in the sessions reflects the conclusion that pre-service teachers were able to recognize their own learning moments, and the type of engagement that helped them achieve this learning. The information collected in the reflective session evaluations was useful, but fails to measure the significance or depth of the learning moments. Additional qualitative information was gathered to determine other learning moments by asking participants to identify their "a-ha" moments during the debriefing session at the end of the day. The responses were overwhelmingly positive, and they supported the idea of significant learning moments by verbalizing specific activities, experiences, and attitudes toward STEM education. Debriefing session notes and videos provided compelling testimony from pre-service teachers and clinical educators that the iSTEM conference needs to become an annual event. This reinforced the usefulness of conferences as effective pre-service teacher professional development option.

Session Evaluations

The session reflections were made up of five questions, one open ended question, two selected responses, and two that collected data through a Likert scale or selected

response. The questions provided a large amount of data to be collected, analyzed, and interpreted.

RQ1: Session Evaluations. This was an open ended question where participants responded with a wide variety of answers. The total number of words in their answers was over 5000. Themes were derived based on frequency of use. The ten most often reported responses were collected. Analysis provided evidence that participants were willing to use technology and activities in their instruction, and would allow students to be actively involved in their learning. It was noted that participants were likely to integrate what they learned in their instruction after attending the sessions. However, the results did not assess the objective of participants learning how to integrate STEM skills into their instruction, as that was not included in the question.

RQ2: Session Evaluations. Participants were able to recognize their learning moments, but did not relate those moments directly to STEM skills, as the question posed did not ask for that specific information. The question gave four responses for participants from which to select an answer to the question - Direct Instruction, Observations, Exploration, and Collaboration. Based on the number of responses, participants chose more than one strategy and offered a few that were not listed. Most participants chose “Exploration” as the learning strategy that contributed most to their learning. “Observation” was the least selected strategy which indicated it was a methodology that participants are not as receptive to experiencing. Having sessions that incorporated hands on exploration was one of the foci and goals of the conference.

RQ3: Session Evaluations. Like Question 2, these evaluations were also intended to align to objective 5: *Participants were able to recognize their learning moments and*

how they related to the "four C's." In response to the questions, *"In which of these "four C's were you engaged during this session?"* the choices were Communication, Critical thinking, Collaboration, and Creativity. "Creativity" was chosen as the "4 C" most used during their sessions. Having sessions that engaged participants in creative ways likely helped them embrace new approaches to teaching and learning. These innovative and new ways to look at education will likely move students beyond the basics. However, the question did not specifically link STEM activities in which participants were engaged and learning moments. Therefore this objective was not precisely assessed.

RQ4: Session Evaluations. Most participants used an interactive sliding scale from zero to 100 to rate how the sessions enhanced their confidence to provide STEM instruction. Participants reported an increase in their confidence for integrating STEM into their instruction. The question directly asked about increased confidence for integrating STEM so from participants' perspective, this objective was met.

Some participants opted out of completing the survey using Qualtrics online and completed a paper copy of the survey instead. The paper surveys posed the same question, but participants were given the following choices in place of a slider: Strongly Disagree, Disagree, Uncertain, Agree, and Strongly Agree. There was a high number of participants (53) that stated they believed their confidence would increase when including STEM instruction into their lessons. Therefore both the electronic responses and the paper responses indicate that the objective was met in the sessions.

RQ5: Session Evaluations. Participants were given a sliding scale to rate how likely they would be to use the instructional ideas from the session. The scale ranged from 0 to100 and the overall mean was determined from the data to be 86.5%. Paper

surveys were slightly lower at 82%. Based on the outcome of this data, participants were likely to use the instructional ideas from the sessions they attended. The question did not address increasing STEM integration into their instruction, making it difficult to determine whether or not Objective 3 was met. There was evidence of increased commitment for integrating STEM into their instruction, meeting objective 3 because the instructional ideas were STEM-related. The participants reported mean score indicated increased importance of and confidence in STEM-integration, however, documented classroom instructional effects would need to be observed and measured in future research to better evaluate the objective.

Paper surveys posed the same question, but participants were given the following choices: Strongly Disagree, Disagree, Uncertain, Agree, and Strongly Agree. The results were (7.4%) Strongly Disagreed, (2.9%) Disagreed, (7.4%) Uncertain, (32.4%) Agreed, and (50%) Strongly Agreed. Seven people (10.3%) stated that they would not use the strategies presented in the session in their classroom. Although we hoped that everyone who attended a session would be able to apply some aspect of the content presented, having only seven mark disagree or strongly disagree was encouraging and may have been due to participants who perceived that the conference was unrelated to their teaching disciplines, or to uncontrolled variables. Several participants mentioned in debriefing that they were unable to relate session content to their disciplines: a physical education teacher, a social studies teacher, and one who taught foreign language expressed those sentiments. Knowing this may shed some light on why participants determined that the sessions did not provide them instructional ideas to use in their own classrooms.

Summative Conference Evaluation

"Active participation within sessions" contributed most to student learning as selected by 86.3% of the respondents. The element of gamification was the most highly rated element of the conference, based on the enthusiasm expressed by participants as they collected beads to represent some form of achievement. Active participation and the ability to acquire more beads were directly proportional, contributing to a sense of fulfillment or accomplishment.

The only two strands that did not have a minimum score of zero were "Active participation within sessions" and "Presentation content." A zero in the range of 0-100 indicates that the element had no significance / impact at all. The conclusion can be drawn, therefore, that everyone at the conference thought there was some level of significance to that element. The competitive game-like atmosphere and active sessions had a positive impact on how pre-service teachers viewed the conference. The call for presentations specifically asked for engaging presentations that would inform, innovate and inspire participants. The iSTEM conference logo included the mantra, "inform, innovate, inspire," to establish the overarching expected outcomes of the conference.

Discussions outside of sessions were rated the lowest in effectiveness, and was the only category to not receive a maximum score of 100. This means none of the pre-service teachers thought discussions outside of sessions was extremely effective.

SQ1: Summative Evaluation. The summative evaluation began with an open-ended question about the importance of STEM integration. Question one, was paired with objective one, which focused on commitment and confidence in integrating STEM into instruction. The question specifically asked participants why STEM integration has

become so important. Responses indicated that 28% of the attendees believed that STEM integration was important because of the impact it has on student learning. The open-ended replies showed a sound understanding of the relationship between teaching and learning. They also conveyed ways in which increased confidence in STEM education can result in increased STEM integration in the classroom.

Analysis of the data indicated that 46% of the responses were coded as related to "Teacher Performance" and the 39.5% were coded as focusing on "Career Readiness." This illustrated that more people believe that STEM integration in school has the most impact on the educational aspect of schooling or preparing students to learn the academics skills of school and not necessarily the employable vocational skills. Participants believed that STEM integration is most useful in teaching the A, B, C's and the 1, 2, 3's of school as opposed to preparing students for the world of work. Integration is an educational academic tool for instruction and not a career preparation tool. Apparently, some struggled to see how it would be used on a job or to improve a career. Seventy-three and a half percent of the 46 that believed integration was best suited to help in education stated that the focus of the integration was to improve "student performance" and 25% believed it benefitted the teacher and his or her teaching. Even those who saw integration as a career readiness tool believed the focus was on how the students used the skills, (51.3%) and not how the teacher delivered content (44%). In all, the importance of integration was seen as the method used by students to improve understanding and learning the materials presented.

SQ2: Summative Evaluation. In question two, participants were asked to name ways STEM education can be integrated into their instruction. This question was paired

with Objectives 2 and 3. Participants identified teaching as the largest factor affecting student learning. The greatest determinate of the ability of a teacher is the amount of understanding or knowledge they possess about a given topic or academic area. (Lemov, 2010). Ironically, under both objectives, the attendees believed the greatest impact STEM integration has is on the student's knowledge or understanding. Of the responses, 46.1% stated that the major effect on STEM teaching is on student's knowledge or learning.

The question asked if integration was important, and if it benefits the students' formal education and career readiness later. It was found that the majority of the group recognized the importance of immediate acquisition of skills. The second question addressed the immediate acquisition of skills, and how they should be implemented. The use of technology (tools we use) or instruction (things we do in class) was examined. Consideration was given to determine if the direct focus should be the teacher (what he or she does or uses) or the student (how they perform academically or utilize the tools given). The results were very close; 34.5% of the respondents believed integration needed to be instruction or academic focused (teaching across the curriculum, project based learning activities, integration of subjects in one lesson, co-teaching by teachers of two or more subjects during the lesson). Approximately 34.4% felt that the integration should be focused on the technology that could be added or required to be used during the lesson. Unlike the first question, 44.5% of the responses related to how the integration could improve the teacher and what he or she did, and only 27.7% believed it would improve student outcomes.

These two questions support the idea that what the teacher does directly affect the student and the learning that occurs. Although in the first question the respondents understood that integration is important in helping our students learn more, they also understood that it is all in the way that the teacher uses the strategy.

SQ3: Summative Evaluation. Question three gave participants an opportunity to indicate the specific aspects of the conference that contributed to their learning. This question was paired with Objective 4, which references increased confidence for integrating STEM into instruction. Question 3 was a selected response item, and allowed participants to give a numerical value of 0 – 100 for seven activities of the conference including: keynote speaker, presentation content, working collaboratively in sessions, having opportunities to reflect, active participation within sessions, discussions within sessions, and discussions outside of sessions. Active participation within sessions contributed most to student learning (86.31%). This was a direct reflection of the foundations of the iSTEM Conference. Active participation was woven into every aspect of the planning stages including the call for proposals. Using gamification helped amplify the participation. The more participants participated, the more chances they had to earn beads through the extrinsic reward gamification promotion. The visual representation, of a string filled with beads, highlighted a person's involvement and investment in the day. It also gave participants a sense of accomplishment. Earning beads created a competitive atmosphere that positively affected the view of the conference.

SQ4: Summative Evaluation. Question four asked participants what was needed to sustain the learning gained during the sessions, and was linked to Objective 4. Participants identified external factors such as their curriculum, school leadership, and

professional development as the largest factors in sustaining their knowledge about STEM education and integrating it into the classroom.

SQ5: Summative Evaluation. The final question in the summative evaluation, asked participants, "How essential do you feel conferences like this are to your development as a teacher?" This question was not linked to a specific objective; instead, it provided important feedback on how the conference was perceived by participants. The iSTEM conference was held in place of the Grand Seminar, which is one of several all day sessions traditionally offered during the senior academic year by the college of education as a pre-service professional development component of teacher preparation. The conference, overall, yielded an approval rating of 80.45%. Most of the respondents believed the iSTEM conference was either very or extremely essential to their teacher development, and participants cited a need to know more about STEM, including sessions they did not have a chance to attend.

Limitations of the Summative Evaluation. The summative survey asked five questions (three open-response and two selected-response). Participants were more likely to answer the selected response questions on the survey. Summative questions, 1-3, all required participants to record their thoughts. The number of responses for those questions was N=114. Question 3A-G and question 5 were selected response and yielded an N = 156. In addition, the 22 paper surveys did not have the 0 to 100 sliding scale, so an equivalency table was made to quantify the responses. As a result, there is no true quality rating for the summative survey. The data is an estimate of the findings.

Qualtrics did not provide a breakdown for ranges of scores for questions 3A-G. That is, the Qualtrics report showed that a 100 was the highest score given to the keynote

speakers, but it failed to report the number of 100-point scores. Conversely, with the 22 paper responses, replies could be counted for each category. Of the 22 responses, the keynote received 1 – Not At All, 2 – Minimally, 6 – Satisfactorily, 10 – Significantly, 3 – Extremely scores. The Qualtrics data, only supplied the average/mean for each item.

Summary of Debriefing Sessions

Participants expressed the desirability of having strong content and grade-level relevance in the debriefing sessions. STEMES attempted to make those connections because research by Goekmenglu & Clark (2015) supports that need. However, with such a diverse group of attendees, making strong connections for each discipline was a challenge. Broad connections were made that apply to all disciplines, but direct applications were not always obviously inclusive enough to satisfy the desire for specifics. One participant proposed that in future conferences, it might be helpful to survey the participants during registration to see which additional topics could be offered, and would align with Brophy's (2010) observations of motivating young students by giving them choice.

In general, the debriefing session groups provided evidence that iSTEM met all five objectives for most of the participants. Responses to debriefing questions were, for the most part, highly energetic and positive. Several groups summed up the first objective in learning why STEM is so important: "Because it is everywhere!" This reflected a common theme beginning with the opening speakers. The second and third objectives appeared to have been met, as many participants in the debriefing described specific ways they intend to integrate STEM based upon what they learned. Several mentioned

wanting more of the same type of professional development, and their collective enthusiasm was evidence that they had the confidence to be able to use or *integrate* what they learned (Objective 4). Several participants mentioned learning strategies employed during the conference, meeting Objective 5.

Summary of Three Words about STEM and Learning Moments. Open coding was selected as the method to organize the list of terms generated from the iSTEM prompt where participants were asked to write three words that came to mind when they heard the word STEM. As previously stated, the words Science, Technology, Engineering and Mathematics were obvious choices to cluster some of the terms garnered during the prompt. The responses generated phrases as well as single terms. Under the heading, Science/Inquiry, word/phrase submissions such as “hands-on”, “experiment, and “lab-work” were traditional terms associated with understanding of science by the participants.

The majority of pre-service teachers who attended the conference were elementary teachers. Beyond courses in science teaching methods and mathematics teaching methods, many elementary teachers do not have content specific majors at this university. The responses indicated that the participants had a surface or generalized understanding of science. Under the category, Technology, the word “technology” was recorded 18 times out of 155 entries. In addition, the words “tech” and “computers” were both recorded once. This again indicates a limited scope of understanding technology. Understanding technology as the application of scientific knowledge was not evident in the responses. Under the heading, Engineering, the word “engineering” was submitted six times out of 155 entries. Finally, under the heading Mathematics, responses included the words/phrases, “math, mathematics, numbers, calculation, engaging hands-on math, and

lots of math." These results again correlated with limited scope of mathematics understanding since the participants were predominantly elementary-based.

Other headings. The inclusion of the 4 C's (Creativity, Collaboration, Communication, and Critical Thinking) was purposefully used as a heading since one of the main goals of the conference was its connection to the 4 C's. Words and phrases associated with the 4 C's warranted its own heading. Collaboration and creativity were the more frequent word choices under this heading, while words/phrases associated with critical thinking were not as prevalent. The word "communication" was only recorded three times. The implications of these word/phrase submissions was that the sessions which were attended emphasized the use of creativity and collaboration in planning STEM related lessons. Communication and critical thinking may not have been explicitly emphasized during the sessions.

The heading, "Qualifying Descriptors", was used to house words/phrases that participants used to describe their feelings about STEM. The words seemed to be the result of internal reflection about STEM. Words and phrases such as "fun, hard, imperative, difficult but important" revealed that the participants were not necessarily comfortable with the ideas of STEM implementation. It is common for elementary teachers to experience some forms of anxiety over teaching STEM subjects, specifically science and math, which may be due to their "constrained background knowledge, confidence, and efficacy for teaching STEM" (Nadelson et.al., 2013). The majority of the responses in this category were positive. Of the 42 entries recorded under the category, Qualifying Descriptors, 32 (76.2 %) of the terms reflected a positive attitude about STEM. This could indicate that the participants had positive experiences with STEM

prior to attending the iSTEM conference, or that the participants had positive experiences in the sessions they attended during the iSTEM conference. The assumption is with the latter, as supported by the results of the post conference evaluation.

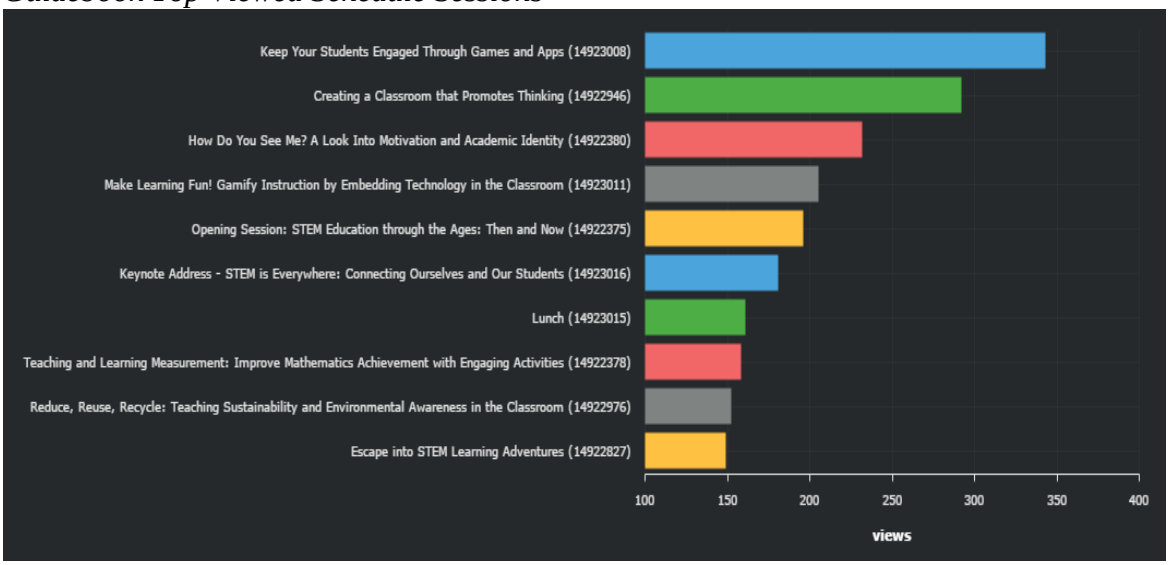
The final four headings used during the open coding to the "3 words about STEM" prompt were STEAM, collegial, hipster, and other. These terms provided some demographic characterizations of participants. Under the STEAM heading, it was evident that some participants felt art was not emphasized or promoted during the iSTEM conference. They included words/phrases such as, "missing the 'A' " and "please include art." There was a continual debate amongst the STEM Education Scholars (STEMES) Cohort about including the "A" for arts. The group concluded that STEM was appropriate and that continuing to try to accommodate more disciplines would make STEM and the iSTEM conference too cumbersome. The conference proposal called for sessions that were interdisciplinary as a compromise to not explicitly including art in STEM.

Collegial was another heading that provided some insight into the demographics of the participants. It was expected that students in the college of education would include education jargon in their responses. Terms such as "knowledge, cross-curricular, integration, intelligence, metacognition, cross-pollinating, and logical" revealed participants' exposure to educational practices and terminology. The heading Hipster, was a refreshing addition to the open coding results. Words such as "real, cool, baller, tight, and sweet" indicated the age group of some of the participants. The use of common vernacular to express a position on what STEM brings to mind provided an understanding of the youthful demographics of some of the pre-service teachers. Finally, the heading, "Other, was used to house terms that did not fit into any of the other

headings. Terms such as “flowers, rainbow, space, and faith” did not seem to hint towards any beliefs or understanding about STEM. However, other terms under this heading did provide some interesting information about preferences of the participants. The phrase “more beads please” revealed that the gamification element of the conference in which participants were able to win beads for participation was popular and worth mentioning. Another term, “Friday,” could have indicated that the participants were happy that it was the end of the week, or that they really enjoyed this particular Friday event of having a conference in place of their regularly scheduled Grand Seminar.

Guidebook ® Conference App. The Guidebook ® conference app provided metrics of participant usage. One particular metric was “Top Viewed Events.” This data included a graph of the top 10 most frequently viewed sessions.

Figure 10
Guidebook Top Viewed Schedule Sessions



The top session, *Keep your students engaged through games and apps*, was viewed 343 times. One aspect of those sessions most highly rated was that they had

buzzworthy titles. These sessions included words and phrases such as, games, apps, promote thinking, gamify, STEM, engaging and environment. These sessions garnered more responses than other sessions that did not include such terms. During one of the debriefing sessions, participants discussed excitement with learning about new games and apps to use in the classroom, but they felt they were missing discussions about the pedagogy to sustain such approaches. Sessions that did focus on pedagogical approaches were not as well attended as sessions that boasted a STEM affiliated or buzzworthy titles. Some session titles may not have been as attractive to participants as others, or the participant may not have felt they understood how the session was connected to the STEM theme.

Other sessions that were well attended did not have STEM or a buzzword in their title at all. Their titles dealt with topics that were of special interest to novice and seasoned educators, alike. These sessions focused on ideas such as academic identity, environmental awareness, and agriculture. This may seem in opposition to the statement above regarding buzzworthy titles. The clarification comes in that both sessions with buzzworthy titles and sessions about general education concerns were well attended, while sessions that focused on pedagogy were not as well attended. Another rationalization for why some sessions were well attended and others not could have been related to the location of the session rooms. Rooms on the top floor of the conference venue were not as well attended as those on the main floor despite the availability of an elevator and stairwells.

Learning Moments. The Guidebook App contained a social media interface that allowed participants to capture moments of the conference and add them to the *Learning*

Moments Photo Album. Participants took pictures of themselves engaged in sessions, as well as photos of the keynote speaker event. Several photos displayed participants showing off their beads earned through active session participation. The images show that participants were extremely enthusiastic about the gamification element of the iSTEM 2017 Conference. Another show of enthusiasm during the conference was the availability of ribbons to attach to the nametag. The ribbons allowed participants to identify themselves in many ways. Some examples of ribbons chosen were lighthearted statements such as, "I <3 meetings," and "My ribbon is better than yours." Some ribbons simply contained emojis, small icons that express emotions, such as a smiley face. The learning moments shed powerful light on the overall attitudes of the participants, as well as displaying different ways in which the pre-service teachers were engaged in the events of the iSTEM conference.

Theoretical Contributions

The practical application of innovative STEM instruction and theory through a diverse, intensive professional development conference for pre-service teachers was explored. The findings complemented supporting research in three important ways. First, the conference format was designed and guided by meaningful engagement principles as outlined by Barkley (2009) and James (2015). These principles inspired a learner-centered approach that actively engaged participants in the development of their own individual experience and process of learning. Pre-service teachers were given the opportunity to choose relevant sessions to attend that sparked their curiosities and interests. In many traditional classroom settings, teachers are the driving force behind the

content, activities and participation of the students. The iSTEM 2017 conference encouraged pre-service teachers to forge their own path for learning, discovery, and professional development. When learners are provided options to act as co-creators in the learning process, learning and student motivation increases (McCombs & Whistler, 1997). Learner-centered approaches also emphasize the importance of reflection. The focus of the debriefing session was to allow pre-service teachers (learners) time to reflect on their experiences throughout the day by discussing what they learned and how they learned it through casual conversations. Reflection activities are essential to learner-centered teaching as it makes students aware of themselves as learners and provides learners with skills they want to develop (Weimer, 2012).

Second, constructivist theories that support learning within a social context (Bandura, 1986), hands-on or experiential context (Dewey, 1938), and active learning context (Bruner, 1966) reinforced the results. Pre-service teachers were asked to identify to what degree each of the conference activities contributed to their learning (see Table 20). Active participation within the sessions achieved the highest average of 86.3 percent, while working collaboratively in sessions scored 82.5 percent. High percentages for both activities indicate that constructivist learning principles contributed significantly to participant learning at the iSTEM 2017 conference. In addition, Maslow's Hierarchy of Needs (1943) shed light on pre-service teachers' motivations to learn. The iSTEM 2017 conference aimed to meet pre-service teachers' *basic needs* by providing comfortable learning environments supplemented with food and drink. *Safety needs* were met by offering conference activities in a familiar and secure space for participants; no threatening or instruction confrontations allowed. *Psychological needs* were achieved by

fostering collaborative environments and activities throughout the day, and by facilitating reflection sessions with already established groups of pre-service teachers and clinical educators. Concentrated efforts were made to acknowledge learning moments and recognize participants who were actively engaged in conference activities. Addressing these stages promotes a learner's ability to achieve *self-fulfillment* and *actualization needs*, which indicates a level of achievement where people realize their full potential (see Appendix C for an illustration of Maslow's Hierarchy of Needs).

Third, "it is believed that the nature of games may facilitate students' engagement and involvement, motivation and interest, and the retention of learned skills" (Cahyani, 2016, para. 4). In an effort to increase participant motivation and interest, a number of gamification strategies were implemented into the iSTEM 2017 conference. Upon check-in, participants received a leather necklace for which they could earn colored beads throughout the day by their participation in activities. Beads could be earned in a variety of ways including, but not limited to, filling out surveys, taking and posting pictures of learning moments to social media sites, actively participating in sessions, asking questions during session activities, and generating conversations with other conference participants about the conference. Participants were able to "cash in" their beads for entry into multiple door prizes, which were given away at the end of the program. Feedback from the conference participants, clinical educators, conference planners and volunteers all indicated that the gamification strategy was a highlight of the conference. There was a rumor that some participants were buying beads from other participants in order to increase their chances for door prizes. That was certainly not what

the organizers planned, but it did indicate how engaged some participants became in the gamification of the conference.

Significant Contributions. The iSTEM conference made important contributions to our understanding of effective principles of engagement for pre-service teacher professional development experiences. Conferences designed to embrace constructivists learning theories and gamification principles offer new ways of conveying STEM education messages. iSTEM 2017 not only increased awareness of STEM education but also provided insights for programmatic changes needed to prepare teacher candidates for the 21st century classroom (Murley, Gandy, & Huss, 2015). The conference served as a model to inform, innovate, and inspire pre-service teachers in STEM education. Participants were:

- *informed* about how STEM instruction can be planned, implemented, and assessed;
- presented with *innovative* STEM research and theory to help integrate STEM instruction in impactful and meaningful ways; and
- *inspired* by interactions with regional STEM professionals who can help enrich instruction and create relevant, real-world applications for students.

Following the iSTEM 2017 Conference, clinical educators met to discuss the overall impact on the instruction of pre-service teachers. Feedback from the clinical educators indicate success in meeting the short-term and long-term conference goals included the following:

Short Term

1. Conveying the importance of STEM integration into the classroom,

2. Providing information about new and emerging careers in STEM, and
3. Presenting research based information on problem and project based instruction.

Long Term

1. Developing positive attitudes towards STEM among pre-service teachers,
2. Infusing the culture of prospective school work environments with STEM, and
3. Connecting participants to community resources and expertise.

Examples:

Clinical Educator- Gallery 2. A group of students in this Gallery sponsored a STEM Night at an elementary for their School Adventure into Learning (SAIL) Project. The students credited their experiences at the iSTEM Conference as inspiring and having provided guidance. At least 704 parents, students, and community members attended the SAIL program. There were food trucks, LEGO robotics, marshmallow bridge construction, and two performances from the Wild Bird Sanctuary administrators/teachers. The pre-service teachers collected data on the total number of participants and favored activities. Participants were able to purchase pieces of duct tape, which were later used to tape a teacher to the wall. This taping was considered a tremendous success; the principal at this school was an active participant, and the there are plans to have the next group of practicum students produce a similar project.

Clinical Educator – Gallery 7. Practicum students in this Gallery planned to conduct "STEM Days" for their SAIL project. It was planned for the third grade students during MAP (Missouri Assessment Program) testing. It was held April 24-26th at an elementary school in their participating school district.

Limitations

Though the iSTEM 2017 Conference yielded impressive feedback from pre-service teachers, there were some issues worth noting. Qualtrics was used as a platform to administer pre and post conference surveys, session evaluations and summative evaluations. In addition, paper copies of the surveys were available. There were some differences between the types of responses solicited on the digital forms through Qualtrics and the paper forms. This resulted in the use of a grade scale conversion to equilibrate the results. Some essential data may have been lost in translation as the paper copy results were entered into Qualtrics.

The debriefing sessions were captured on video and/or audio. Reviewing the video/audio content on Teacher Channel, it was noted that the sound quality was poor. It would behoove conference planners to set up microphones or recorders to more accurately capture the responses of the participants. Also, there was variation in how the debriefing sessions were conducted. In some cases, the Clinical Educators were asked to facilitate the session while the attending cohort member captured field-notes on participant responses. In other cases, the cohort member led the session, but there was no one there to capture the responses except the pre-service teacher chosen to serve as the videographer. Some of the actual meaning may have been skewed or lost depending on how the moments were captured or lost.

The conference platform was suitable for the time period in which it was planned, but many participants expressed the desire for more sessions from which to choose. As it was, participants were only able to choose two sessions. Session attendance seemed to be heavily influenced by the session name. Larger crowds were present in sessions that

mentioned using technology, apps, or games to engage students. Pre-service teachers also chose sessions that focused on cultural competence and awareness in STEM classrooms. Sessions that were pedagogy-driven were under-attended, though some students in the debriefing session stated that pedagogy was something they thought was missing.

Another notable limitation of iSTEM 2017 was that the target audience was limited to individuals who had not necessarily been in the classroom. The participants were classified as Practicum I or Practicum II students. Practicum I students have little to no classroom experience. Practicum II students have some experience with student teaching, but are still under the supervision of their cooperating classroom teacher.

The attending pre-service teachers were fundamentally a required audience (the result of convenience sampling), as attending this conference was mandatory and counted for points towards their final grades. Though conference attendance was mandatory, the pre-service teachers were adamant about having another conference of this type with more sessions. Pre-service teachers were overwhelmingly positive about the structure of the conference and the idea of having a conference in place of one of their regularly scheduled Grand Seminars.

The original idea for iSTEM 2017 was to invite practicing area educators, from both K12 institutions and surrounding universities. Issues that arose included substitute teacher shortages that impacted teacher availability. The conference day, Friday, March 3, was problematic in that most districts discourage teacher absences on Fridays and Mondays, which are the more prevalent days for reported absences, and subsequent substitute teacher staffing issues. In the future, the conference will be marketed to a larger

audience, and consideration will be given to choosing a date that does not conflict with pre-planned school events.

Future Studies

Information from the debriefing sessions as well as the pre-conference, post conference and summative evaluations provided some valuable insight into the needs of pre-service teachers. STEM is a term that is growing in popularity, but more understanding around STEM practices is needed. Establishing a post conference blog where participants can post some of the ways they are integrating STEM into their practices could be beneficial and insightful. This blog could also serve as a platform for pre-service and practicing educators to share their burning questions about STEM integration in addition to sharing best practices and reflections. Additional ideas about session topics could be generated from such a blog to provide continual inspiration for iSTEM conferences of the future.

Future research could include longitudinal studies of pre-service teachers, their transition to practicing teachers, and how they integrate STEM practices into their classroom instruction.

Adding to the ongoing debate over a clear definition of STEM is the continued view of STEM only in terms of the acronymn's namesake. Some pre-service teachers can define STEM as "Science, Technology, Engineering, and Mathematics," but there does not seem to be much depth of understanding beyond that definition. Therefore, it is incumbent upon university teacher preparation programs to address the issues of what STEM is and to clarify the pedagogical aspects of STEM for pre-service teachers. In essence, help pre-service teachers see STEM as more than fun activities or building

bridges, but transition their understanding of STEM to include content mastery as well as integration of critical thinking processes, collaboration with peers, communication, and creativity. Increasing exposure to STEM related learning through methodology courses and professional development opportunities such as the iSTEM conference can positively impact teacher confidence and affect their personal view of themselves as STEM-capable educators who support STEM-capable learners.

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Appendix A

Proceedings Document

iSTEM 2017

UMSL

iSTEM

inform, innovate, inspire

Conference Proceedings

February 3, 2017

HTTPS://GUIDEBOOK.COM/GUIDE/84720/

2017 STEM Education Scholars

APPENDIX A

iSTEM Conference Proceedings

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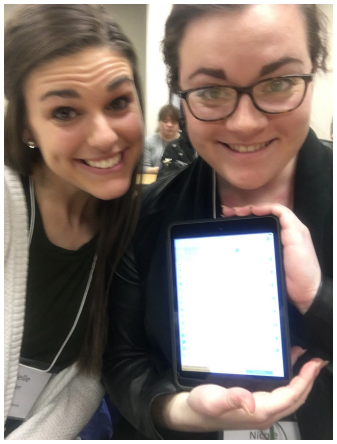
Conference Schedule at a Glance

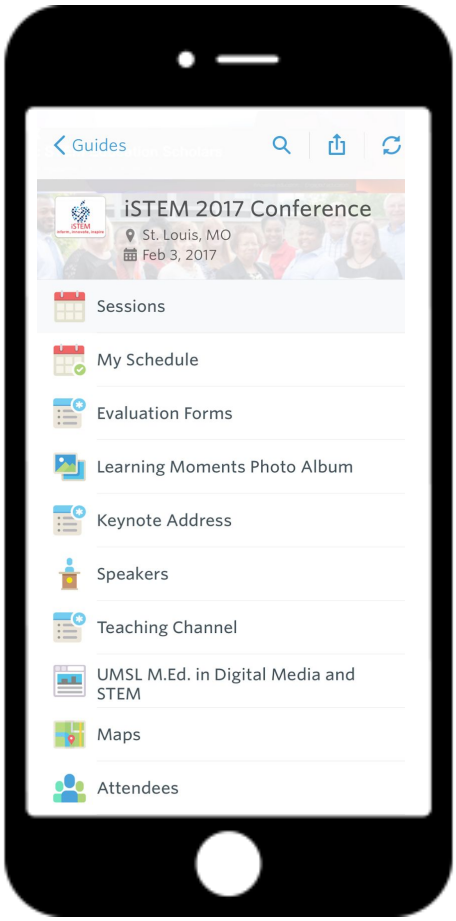
8:30 - 9:00	**Registration** (JC Penney Lobby)								
9:00 - 9:30	Opening Session and Welcome **STEM Education through the Ages: Then and Now** (JC Penney Auditorium 101)								
9:45 - 10:45 **(50 min session; 10 minute eval time)**	**Breakout Sessions - Block 1**								
	Session 1 Teaching and Learning Measure-Ment (JCP 62)	**Session 2** How Do You See Me? (JCP 64)	**Session 3** Increasing Student Problem-Solving Skills (JCP 92)	**Session 4** Escape into STEM Learning (JCP Summit)	**Session 5** Creating a Classroom that Promotes Thinking (JCP 202)	**Session 6** Engaging K-12 Students (JCP 204)	**Session 7** Reduce, Reuse, Recycle (JCP 402)	**Session 8** Modeling and Discourse to Scaffold Science (JCP 403)	**Session 9** Using Engineering Design Challenges (JCP 404)	**Session 10** The Algebra of STEM (JCP Hawthorn)
	Helene Sherman	**Christopher Young-El**	**Rosalinda Williams**	**Keith Miller**	**Deborah Heisler**	**Nicolle von der Hyde**	**Maggie Peeno & Diane Papageorge**	**Christina Hughes**	**Robert Powell**	**Lane Walker**
11:00 - 12:00 **(50 minute presentation; 10 minute eval time)**	**Breakout Session - Block 2**									
	Session 11 Orchestrating Productive Math Discussion (JCP Cypress)	**Session 12** Working Together to Create Meaningful STEM Experiences (JCP 64)	**Session 13** How STEM Helps Early Childhood (JCP 92)	**Session 14** The Sound of Color (JCP Oak)	**Session 15** Keep your Students Engaged Through Apps (JCP 202)	**Session 16** Connecting Curious Minds to Ag (JCP 204)	**Session 17** Make Learning Fun! (JCP 402)	**Session 18** Pre-Engineering Design and Video (JCP 403)	**Session 19** Mental Models: STEM Teaching (JCP 404)	**Session 20** Reimagine Assessment Using STEM (JCP Hawthorn)
	Nevels Nevels	**Amy Dooley** **Melissa Hurayt**	**Skyler Wiseman**	**Keeta Holmes**	**Abby Branstetter**	**Gillian MacQuarrie**	**Pamela Atkinson-Hamilton**	**Gloria Hardrict-Ewing**	**Nancy Lewis**	**Tiffanni Durham**

12 - 1:00	**Lunch** (JC Penney Summit, Oak, Cypress, Hawthorne)
1:05 - 1:55	Keynote Address **STEM is Everywhere: Connecting Ourselves and Our Students**
1:55 - 3:00	**Discussion with Clinical Educations** Conference Evaluation
3:00 - 3:30	**Closing Remarks/Door Prizes** (JC Penney Summit)

Guidebook



Guidebook's app builder was chosen to make an interactive mobile guide for the conference. The app provided access to an interactive schedule builder, social networking, interactive photo album, presenter information, and real-time polling and discussions. It was important to incorporate technology to illustrate innovation and interactive technologies pre-service teachers might use for their own educational events. In addition, use of the app minimized the expense and waste of printing conference agendas, a value shared in several iSTEM program sessions. By using this app we were able to create an engaging digital community with personalized content. All organizers, speakers, and attendees joined in the conversations and the app provided a central place for attendees to discover content, share photos, and engage in discussions. The mobile app also kept everyone up-to-date by being able to send important messages directly to the users' home screens throughout the day.



Meet the STEM Education Scholars (STEMES)

The STEM Education Scholars (STEMES) Cohort consisted of four University of Missouri-St. Louis professors and ten STEM Education Scholars.

Faculty Advisors

Professor Keith Miller, PhD.
Orthwein Endowed Professor for Lifelong Learning in the Sciences

Professor Helene Sherman, Ed.D.
Founders Professor
Professor Emeritus

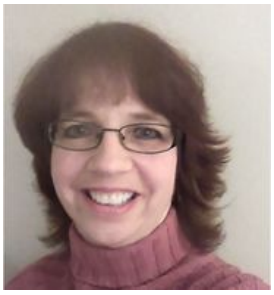
Professor Carl Hoagland, Ed.D.
Emerson Electric Endowed Professor of Technology and Learning
Executive Director of the E. Desmond Lee Technology and Learning Center

Professor Charles Granger, Ph.D.
Professor of Biology and Education
Curators Distinguished Teaching Professor

Degree Listings and iSTEM Conference Presentations of 2017 STEMES Cohort

	Pamela Atkinson-Hamilton Ed.S., University of Missouri – St. Louis, 2011 M.Ed. Admin, University of Missouri-St. Louis, 2003 B.S., Harris-Stowe State University, 1996 iSTEM Committees: Facility Technical Liaison Chair, Mailing Lists, Registration, Exhibitors, and Volunteer Chair
	Amy Dooley M.A., Lindenwood University, 2008 B.A., University of Northern Iowa, 1998 iSTEM Committees: Conference Agenda, Branding and Design, Call for Presenters' Chair, Evaluations Committee, Keynote Chair
	Tiffanni N. Durham M.Ed., University of Missouri-St. Louis, 2010 M.B.A., Ball State University, 2005 B.S., Tennessee State University, 2003 iSTEM Committees: Conference Branding Chair, Marketing and Advertising Chair, Proceedings, Website

	Gloria J. Hardrict-Ewing M.A.Ed. Admin., Lindenwood University, 2008 M.A.Ed., Lindenwood University, 2002 B.S., University of Missouri-St. Louis, 1993 B.A. Public Admin., Roosevelt University, 1975 iSTEM Committees: Conference Committee, Final Edit Committee Co-Chair, Evaluations Committee, Proceedings Document Chair, IRB Chair, Liaison to Clinical Experience Department-College of Education
	Deborah J. Heisler B.S., University of Missouri-St. Louis, 2004 iSTEM Committees: Audio-Visual, Marketing and Advertising, Mailing List Chair, Proceedings Document Assistant Chair, Marketing and Advertising, Facility Liaison, Catering Chair
	Keeta M. Holmes M.A., Russian and Second Language Acquisition, Bryn Mawr College, 1998 B.A., Russian, University of Kentucky, 1995 iSTEM Committees: Conference Chair, Agenda and Program, Call for Presenters, Catering, Registration, Proceedings Document

	Christina W. Hughes M.Ed., University of Missouri-St. Louis, 2010 B.S., Alcorn State University, 1998 iSTEM Committees: Conference Chair Assistant, Website Chair, Final Edit Committee Chair, Keynote, Final Document Submission, Conference Proceedings (online)
	**Lane H. Walker** M.Ed., University of Missouri, 2004 B.S., Harris-Stowe State University, 2001 iSTEM Committees: Conference Committee, Conference Agenda Chair, Keynote, Call for Presenters, Name Badges, Volunteer Committee, Evaluation Chair
	Rosalinda D. Williams M.A., Lindenwood University, 2010 B.S., University of Missouri-St. Louis, 2005 iSTEM Committees: Audio-Visual Chair, Name Badge Chair, Registration Chair, Marketing and Advertising, Mailing Lists
	Christopher M. Young-El Ed.S., University of Missouri-St. Louis, 2008 M.Ed., University of Missouri-St. Louis, 2003 B.S.Ed., Harris Stowe State College, 2000 iSTEM Committees: Conference Agenda, Conference Branding, Volunteer Committee, Sponsors and Exhibitors Chair

Keynote Address

Deborah Holmes was chosen as the Keynote Speaker for the iSTEM conference for many reasons. She is a great speaker and is passionate about STEM. Being a teacher for many years herself, she can relate and understand pre-service teachers' needs and wants. Her presentation was entitled "STEM is Everywhere: Connecting Ourselves and Our Students". During her address, she explored STEM opportunities and considered ways to "stemitize" classroom curriculum through meaningful and personal connections that develop the STEM-capable learner in all of us.

Deborah Holmes is the Project Manager/facilitator for STEM Teacher Quality, an initiative of STEMpact, a St. Louis regional corporate collaborative representing over $150 billion in STEM earnings. STEMpact is committed to advancing the quality of STEM instruction to prepare and inspire students to become STEM proficient and ready to explore STEM Careers. STEM Teacher Quality provides high-quality professional development aimed at increasing the number and diversity of students who are STEM-capable learners by developing STEM-capable teachers.

Previously, Holmes served as Assistant Superintendent for Curriculum and Instruction in the Kirkwood School District from 1990-2011. In this capacity, she was responsible for teacher training, student achievement, school improvement, and technology integration. Prior to Kirkwood, she was principal of Brittany Woods Middle School (Missouri Blue Ribbon School), and Jackson park Elementary School (Recognized for Distinction by the U.S. Department of Education) in the School District of University City. Holmes began her teaching in Lawrence, Kansas. Both B.S and M. S. degrees are from the University of Kansas and her Ph.D. is from St. Louis University. Early in her career, Holmes wrote teacher resource books, articles for professional publications, and grants. She has served as an adjunct faculty member at three St. Louis area universities, is a certified strategic planner, and an inclusion and diversity trainer in educational and corporate settings.

BREAKOUT SESSIONS BLOCK 1

9:45am to 10:45am

Creating a Classroom that Promotes Thinking

Deborah Heisler, Middle School Mathematics Instructor

What's Going on in Their Heads? The purpose of this workshop is to share ideas and strategies about how to create a classroom that promotes thinking. During the workshop, participants will engage in activities that they can use in their own classrooms.

Engaging K-12 Students in Inquiry and Scientific Explanation

Nicolle Von der Heyde, Adjunct Instructor

Engaging students in inquiry-based instruction is challenging, even for teachers who are experts in science and math. This session will provide practical frameworks to help new K-12 teachers plan and implement STEM lessons around questions, claims, evidence, and reasoning. The 5E Instructional Model (BSCS) and the Claim-Evidence-Reasoning (CER) Framework (Zembal-Saul, McNeill, & Hershberger, 2013) can be used to teach most inquiry-based topics at any grade level. Starting with questions that are relevant and meaningful to students, these frameworks support 3-Dimensional Learning and student engagement in Science and Engineering Practices. The session will provide examples of K-12 unit plans that use these frameworks and align to standards (NGSS, CCSS, or MO Learning Standards), followed by participants designing their own units on topics of their choice. Learning Outcomes: 1. Participants will engage in a STEM lesson that is driven by guiding questions and supports scientific explanation. 2. Participants will use the 5E Instructional Model to design one or more inquiry-based lessons around guiding questions that connect to standards (NGSS, CCSS, or MO Learning Standards). 3. Participants will incorporate the Claim-Evidence-Reasoning (CER) Framework into inquiry-based lessons to encourage and support students' scientific explanation and reasoning.

Escape into STEM Learning Adventures

Keith Miller, Ph.D., Orthwein Endowed Prof. for Lifelong Learning in the Sciences

Behavioral objective: successful participants in this session will design one "escape room" activity for a future learning experience for their students. Overview: The presentation will briefly describe how Vygotsky's zone of proximal development is related to the idea of escape rooms for small groups of people. Next, participants will experience a single puzzle, solved by small groups. Finally, each small group will choose a topic and a grade level, and then develop a puzzle that embodies or reinforces learning an aspect of that topic for students at that grade level. If there is time, the small groups will share their puzzles with other small groups.

How Do You See Me? A Look Into Motivation and Academic Identity

Christopher Young-El, Assistant Principal

Our eyes and ears feed information to our brain that allows us to make judgments about the people and places around us. Often students engage in behaviors that are motivated by external factors. Many times, these judgment calls are inaccurate based on the limited amount of information use to make them or the source or situation by which we came upon it. Imagine being the students that this is being observed or judged. Every movement, every word, every action or reaction being analyzed Couple this with being an African American Male in an Urban School District where many of your peers are seen as "troubled" youth with an unpromising future. This session will look at perception, motivation and their relationship to academic performance.

Increasing Student Problem Solving Skills

Rosalinda Williams, Middle School Mathematics Instructor

Based on requirements 21st-century businesses are looking for, being able to work with a team effectively is an important skill to have. Students especially those in Middle school, currently struggle when they are given inquiry type problems to work on in cooperative groups, and sharing their finding with the whole class. Since they have not had practice and are accustomed to the teacher either giving them the formulas to use or walking them through each step, students will sit back and wait for instruction without even trying. My presentation will discuss where students are currently with inquiry learning and what type of problem-solving method is used if any to reach a reasonable solution. I will include problem-solving methods and strategies to use when working in cooperative groups. Educators will learn to be facilitators and allow students to make mistakes, after all, that is when learning takes place.

Modeling and Discourse to Scaffold Student Understanding of Science Concepts

Christina Hughes, Science Curriculum Coordinator

Participants will learn what modeling is and how its practice is enhanced by incorporating discourse in the classroom setting. Modeling will be presented as an approach to scaffold student learning and to build a strong conceptual framework of science understanding. Participants will be equipped with resources about model-based instruction, and they will be engaged in an example of model-based instruction with discourse.

Reduce, Reuse, Recycle: Teaching Sustainability and Environmental Awareness in the Classroom

Diane Papageorge & Maggie Peeno, Clinical Educator Art Practicum

Lessons and activities will focus on science, technology, engineering, art, and math (STEAM) through the work of pre-service and cooperating teachers in UMSL's College of Education. We used a Project Based Learning Model of Inquiry that focused on experiences and tasks that guided students in answering a central question, solving a problem, or meeting a challenge.

Teaching and Learning Measurement: Improve Mathematics Achievement with Engaging Activities

Helene Sherman, Ed.D., Founder Professor, Professor Emeritus

The purpose of this workshop is to engage participants in active, hands-on mathematics activities that lead to the development of students' measurement concepts and related skill practice. The study of measurement is critical to students' mathematics achievement and is one in which North American students commonly score the lowest among other topics on national standardized tests of measurement concepts and procedures. Because this topic also contributes to increasing the understanding of whole number and rational number operations, measurement lessons serve to build conceptual foundations throughout the mathematics curriculum. It is also adaptable to many everyday problem solving opportunities, increasing interest in mathematics and to differentiating instruction. The presentation activities are suitable for first through sixth grade students and build understanding for length, capacity, mass/weight, volume and temperature. Participants will work with place value blocks, handmade and commercial rulers, balance scales, measuring cups, counters, number cubes and games. Participants will also interact in small groups and discuss common student errors and remediation appropriate to misconceptions. Handouts will be provided.

The Algebra of STEM

Lane Walker, High School Mathematics Instructor

As word problems have moved up from Section C in the math textbooks, further analysis has brought criticism of their contrived contexts. Student are not finding those problems to bear convincing evidence of the need to learn algebra, and few find them engaging. Students who remain unconvinced of the value of Algebra are less likely to invest heroic effort to learn it, and socioeconomic disadvantages are thus perpetuated. Efforts are being made to make word problems seem more interesting; however, little has been done to directly relate routine Algebra procedures to the development of generalized, routine thinking such that students see the value of their struggle to learn them (Cognitive theory). Students who associate a higher degree of relevance toward mathematics are reporting feeling more confident, positive, and have better attitudes toward mathematics. In addition, assessment scores appear to be positively impacted Clarke, Breed, and Fraser (2004). Participants will begin to see how thought processes developed within traditional Algebra procedures directly relate to mental processes used in 21st Century Careers.

Using Engineering Design Challenges to Engage Students

Robert Powell, Challenger Learning Center

This session will introduce pre-service teachers to innovative, hands-on experiential learning experiences available to teachers that take students outside of the classroom, such as Little Creek Nature Center and the Challenger Learning Center in the Ferguson Florissant School District. Learn how activities that are done at those locations increase student engagement to science and are connected to state education standards. Participants will have an opportunity to experience a multi-disciplinary activity that uses problem-based learning and integrates technology into engineering design challenges.

BREAKOUT SESSIONS BLOCK 2

11:00am to 12:00pm

Connecting Curious Minds to Ag through STEM

Gillian MacQuarrie, Monsanto Company

Often when we think of "STEM" we think of aviation, space or the medical fields, but there is an exciting field called modern agriculture in need of STEM solutions as well. Participants will learn more about the field and have their hand at hands-on activities. From drones to robotics- it's an exciting time to be involved in modern agriculture.

How STEM Helps Early Childhood Level the Playing Field

Skyler Wiseman, PreK-5th grade Instructional and Curriculum Specialist

Children from underserved populations can enter Kindergarten 18 months behind their peers in vocabulary, social and academic skills and experiences with the environment and science in general. This workshop shares strategies for incorporating STEM into early childhood to increase science, math, engineering and age appropriate technology to help bring ALL children to success.

Keep Your Students Engaged Through Games and Apps

Abby Branstetter, Ph.D Candidate, College of Education

In this hands-on session you will learn how to use applications that inspire students, encourage participation, and most of all, let students have fun while learning. The apps we will explore are:

- **Discovery Education** – with this online tool, teachers can provide high quality learning experiences with virtual field trips and free lessons plans for science, engineering, technology, social studies, math, and language arts in grades K-12. All lesson plans are interactive and fun. With virtual field trips, teachers will be able to take students beyond the classroom walls to explore places across the globe. Field trips include "classroom extensions" that reinforce what they learned through activities and challenges.
- **Kahoot/Plickers/Socrative** – while instructing, teachers will be able to test their student's skills in a game (quiz-like) format. These apps require student participation and keep students engaged. Research has shown that recalling information is one of the best ways to help with retention, why not quiz your students in a way that is exciting, fun, and even sometimes competitive.
- **BreakoutEdu** – Escape Rooms are becoming increasingly popular around the world for recreational purposes. Now, using active learning strategies, teachers can create an escape room in their classroom. BreakoutEdu has many pre-made escape rooms, or you can create your own. Students will need to use teamwork, problem solving, critical thinking, and troubleshooting to solve the clues and puzzles. Each room has a theme, video, and instructions for K-12 math, science, history and language arts.

Teachers will leave this session with loads of new ideas and lesson plans to incorporate into their classroom. Learning should be fun and exciting. By incorporating these problem/project based applications and experiences, your classroom will be fun, engaging, and hopefully the class that all the students look forward to.

Make Learning Fun! Gamify Instruction by Embedding Technology in the Classroom

Pamela Atkinson-Hamilton, Ed.S., Middle School Mathematics Instructor

This workshop is designed to inform, innovate, and inspire teachers by introducing interdisciplinary, research-based strategies that can be used to transform traditional classroom instruction. Participants will need a laptop.

Mental Models: STEM Teaching and Learning

Nancy Lewis, Ed.D., Learning Coach & STEMPact Facilitator

STEM teaching and learning is problem solving, critical thinking and innovation. Processing through the lens of Systems Thinking strengthens the educator's ability in these areas. Participants will examine mental models and reflect on their relevance and relationship to the practice of teaching.

Orchestrating Productive Mathematics Discussions

Nevels Nevels, Ph.D., Mathematics Curriculum Coordinator

Classrooms discussions about mathematics can be difficult to begin or manage. Classroom discussions need to be purposefully orchestrated using 5 principles: Anticipating what students may do, Monitoring what students are doing, Selecting student work to discuss, Sequencing the student work in a purposeful order, and Connecting students work to each other and to the mathematics to be acquired as a result of the activity.

Pre-Engineering Design and Video Reflection

Gloria Hardrict-Ewing, M.Ed., Graduate Research Assistant

Today, the NGSS suggests that engineering concepts be introduced to students as early as kindergarten. When students surveyed by the Boston Museum of Science were asked, "What is an engineer?" most responses referred to persons having specialized jobs such as mechanics. After the students participate in the Engineering is Everywhere curriculum, they will be able to more correctly describe engineers as people who design, create, or improve technology. In this hands-on workshop, the participants will be instructed on the Engineering Design Process, discuss alignment of instruction with the NGSS and MO State Science Standards, identify a design problem, and work in pairs or groups to brainstorm solutions and create a prototype. The participants will learn to create a problem-based engineering unit or lesson. They will also create video recordings of their learning experiences to use for reflection to improve future lessons. The participants will form groups and be given a common problem to solve. All groups will brainstorm ways to design sustainable housing using shipping containers. Links will be made to the participants' prior knowledge of tragedy that accompanies storms like Katrina, floods in Missouri, and Hurricanes in Florida, and Tornadoes in the Midwest. The engineering design process and the NGSS will be presented, and a design rubric will be distributed and discussed.

Re-imagine Assessment Using STEM

Tiffanni Durham, M.Ed.., M.B.A, High School Mathematics Instructor

Re-imagine Assessment Using STEM will focus on alternative ways of measuring student learning outcomes that can replace or accompany traditional modes of evaluation. Emphasis will be placed on performance-based projects that allow students to demonstrate understanding of major concepts, while incorporating multiple strands of STEM. Performance-based assessments can shift the classroom dynamic to focus on effective modes of communication and collaboration rather than the isolated application of facts. Participants will also be presented with methods to evaluate alternative assessments and how to properly match the assessment with the best evaluation tool. This session will require active participation in at least one hands-on activity.

The Sound of Color: Collaborative Inquiry

Keeta Holmes, M.A., Director, Faculty Development, Center for Teaching and Learning

Futurist poets created their own set of sounds to transcend language to elevate the mind into the natural world. The sounds are meant to evoke a sense of color, emotion, and feeling, but is it real? Let's apply the scientific method to test their theory of language, color, and sound.

In this session, you'll experience the world of sound and color by working in teams to write a three-step hypothesis about whether a relationship exists between sound and color. In your team, you'll choose Door #1 or Door #2 to use different data sets to test your hypotheses. Along the way, you'll learn how these approaches improve students' critical and creative thinking in STEM disciplines and beyond.

Working Together to Create Meaningful STEM Experiences

Amy Dooley, Director, Jefferson Farm and Garden
Melissa Hurayt, Volunteer Coordinator, Education Department, Wild Canid Survival and Research Center

Working Together to Create Meaningful STEM Learning Experiences aims to bridge the gap between in school and out of school experiences. Pre-service teachers will be introduced to informal educators from the St. Louis Zoo, Missouri Department of Conservation, and Jefferson Farm and Garden, who will share lessons learned and facilitate hands-on activities that highlight successful STEM learning both in and out of the traditional classroom setting. These hands-on activities provide opportunities for teachers to offer relevant, engaging, and purposeful experiences that will have students thinking, acting, and learning like scientists, engineers, and other professions within the STEM field.

Photographs from iSTEM 2017

Cohort Members' Conference Reflections

Pamela Atkinson-Hamilton

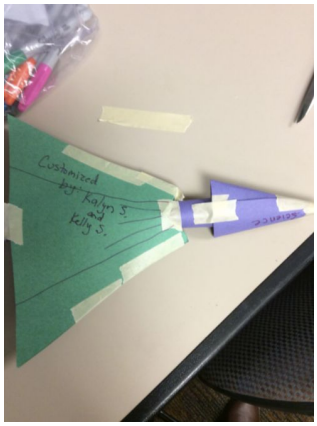
I thought iSTEM conference proposed objectives were clearly met.

1. Participants will be able to answer these questions:
    a. Why has STEM integration become so important?
    b. How can STEM skills be integrated at the level I teach? (various sessions with hands-on examples, collaboration and brainstorming)
2. Participants will report increased commitment to integrating STEM in their classroom and increased confidence in doing so.
3. Participants will recognize learning moments and relate those to STEM skills (the Four C's)

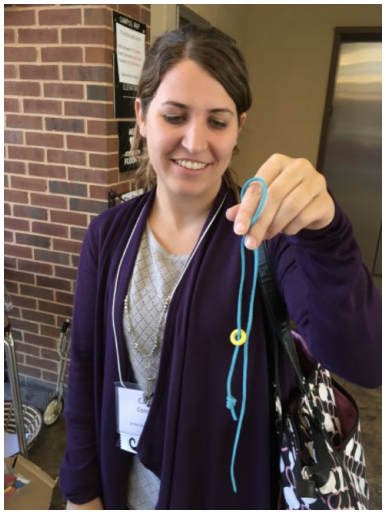
I was impressed with the conference structure, layout, and number of hands-on and engaging STEM activities that were offered. Based on feedback from debriefing sessions, participants were overwhelmingly captivated with the conference sessions and loved the idea of using the Guidebook app. We knocked it out the park!

Gloria Hardrict-Ewing

In my opinion the iSTEM (Interdisciplinary Science, Technology, Engineering, and Math) Conference was a huge success. Many of our objectives were met, the participants reported intentions of using strategies learned at the conference, and a buzz about the importance of STEM (Science, Technology, Engineering, and Math) was created. Single professional development events do not encourage retention or transferability of learning. In support of that theory, STEM breakout sessions were included in the monthly Grand Seminar meetings of the pre-service teachers. The STEM education offered in the conference and seminars was introductory in nature, designed to support the pre-service teachers in gaining confidence and competence in STEM educational practices. Going forward, it is my hope that the pre-service teachers will strive to utilize interdisciplinary instruction, and continue to pursue STEM professional development opportunities. Teaching students to problem-solve and be creative, will help teachers prepare students for careers and jobs not yet imagined. Gaining more knowledge of applying engineering and technology to the real-world will help students realize the relevance and need for such study. Becoming proficient in STEM educational practices will enable teachers to confidently and boldly teach skills that our students will need in the 21st century, and insure national growth and progress.



Keeta Holmes



I agree wholeheartedly with the sentiments of my cohort members. I was thrilled by the enthusiasm and energy the pre-services began AND ended the day with. I marveled at the realization of the atmosphere that we envisioned and planned. As I sat at the Guidebook table, I watched as the pre-service teachers approached the Registration table across the lobby. Most participants smiled when they received both their name badge and necklace/bead. They were directed to the Guidebook table for instructions about what to do next. By the time that they arrived at the Guidebook table, the volunteers explained that throughout the day they'd earn beads for participating and sharing experiences in the Guidebook App. Nearly all participants immediately downloaded the app, took a group selfie with others nearby, and laughed at the pictures others took. Introduction to the day, app, and conference began with smiles and laughter. A small group of 5-7 young women were engrossed with earning more beads and began running around the lobby to take photos, explain to others about the game. Some students rushed to the prize table to see what they would earn. Others examined how to affix the beads to the necklace.

When participants were seated in the auditorium waiting for the opening session to begin, STEM Cohort members awarded beads to those sitting in the front rows and explained to the crowd that bravery earns beads. During the first round of concurrent sessions, I observed how the conveners quietly awarded beads to participants who raised their hands, tried an activity, answered questions, or asked questions. As soon as one student earned a bead, I saw on average 3-5 hands raise immediately afterward with smiles on their faces and eyes on the beads. As students completed their session evaluations, students didn't leave the room without getting their bead. Throughout the hallways, students were arranging their beads in various ways and talking about their creative solutions to managing the beads with each other. I believe that this gave students something fun to talk about with each other. When students were in line to exchange their beads for door prize tickets, over 10 students replied saying that they were reluctant to exchange their beads at all. They loved the beads and wanted to keep them. The session rooms, hallways, and lunch lines were full of energy from the excitement of learning from interactive, hands-on sessions within the joyous environment we had intentionally designed.

Lane Walker

STEM is becoming a social justice issue. In a world that is increasingly dependent upon technology, students who have developed STEM skills have an advantage over students who have not. Whether it is off to college with online quizzes and discussion boards or into the coffee shop where their purchase is mined for data, students who understand technology become empowered beyond those who do not. Teachers who understand STEM and equip their students can help level the playing field between the haves and the have nots. We have a moral obligation to inform the nation's teachers. That calling became clear to me at iSTEM2017.

Faculty Conference Reflections

To: STEM Cadre Cohortees:

To understate our feelings, enthusiasm, impressions, appreciation, appraisal, approval, awe, professional opinions, and pride in regard to the outstanding, administrative and academic excellence that you exhibited in mounting the iSTEM Conference – WOW!!! Congratulations on a great job of teamwork and cooperatively sharing of expertise that lead to a most effective experience. You were excellent role models for the 300 professionals to be and those of us already in-service.

We have been involved in many local, regional, national and international professional conferences, from participating to chairing, and we agree that iSTEM was second to none. Your philosophy, mission and goals were right on target and the structure that you developed to achieve them worked beyond expectations.

The word on the street and in the halls at all levels is that iSTEM set the benchmark for excellence in preservice professional development.

We are very proud to be part of the STEM cohort that you have been able to develop over the past two and a half years. We believe that together you have the potential to make a significant impact on our profession.

Best wishes for continued success,

Your Mentor Colleagues:

Carl Hoagland
Keith Miller
Helene Sherman
Charles Granger

Clinical Educators' Conference Reflections and Notes

Karla Gerke, Clinical Educator

1. I thought the conference was very well organized. I did not see any glitches in the way it was run and I know my teaching candidates and I enjoyed the snacks and lunch that were provided.
2. I think this conference was very relevant. I think too often that teachers who do not teach Math or Science have the attitude that they cannot use strategies used in those two subjects. If we learned nothing else, we learned that all people can be knowledgeable about STEM.One of my buildings is doing a STEM day for their SAIL project and I think they got some very good ideas from this conference. I have a PE teacher that could not see how any of the information related to him. I would suggest that information on kinesiology or the science of movement, etc. be included in future conferences, if possible. I do know that your planning was over the last few years and we only received the PE students into the Studio Schools this semester.
3. The only structural weakness that I saw was that instead of the keynote speaker after lunch, teacher candidates could have had the opportunity to attend a third breakout session. The keynote address in the middle of the day slowed down the momentum of the day. The rest of the day was set up very well, in my opinion.
4. After talking to my teacher candidates, I would like to see this conference continue. They all felt it was well worth their time and my students who got sick and could not attend were very sad, after hearing how great it was! They also felt as though they were being treated as professionals and that is worth a lot!

Thank you very much for this great experience!

Lynne Glickert, Clinical Educator
UMSL Education Coordinator for St. Charles Community College
Office of Clinical Experience and Partnership

1. What was your overall impression of the conference? Excellent
2. How relevant was the conference to the needs of your students? All my students, without exception, enjoyed the day and thought that whatever break-out sessions they attended were relevant to their clinical training.
3. What strengths and weaknesses did you observe in the conference structure? Definitely the hands-on nature of the break-out sessions. Students could immediately take back ideas and use them immediately in their clinical settings. I especially enjoyed the keynote speaker. I can still name the take aways - 'STEM is everywhere' and 'everyone is STEM capable.
4. Would you like to see this conference continued in this, or a different format? I know such a professional roll out took a ton of work on the part of those of you that created and implemented it. I would LOVE to see it continue in similar format - with such excited/engaged break out session leaders with such relevant/hands on learning for our candidates.

Ellen Heavener, Clinical Educator
Clinical Educator - Gallery 9
Office of Clinical Experience and Partnership, University of Missouri-St. Louis

Thanks again for the wonderful conference!

Here is my input from the iSTEM conference.

1. What was your overall impression of the conference? I thought the conference was well developed, planned, thought out went off without a hitch. Candidates I talked with enjoyed going to the hands-on breakout sessions.
2. How relevant was the conference to the needs of your students? The students need practical examples of how to incorporate iSTEM into the curricula in their schools. This conference provided opportunities for the students to come away with examples of how they can incorporate iSTEM in their classes.
3. What strengths and weaknesses did you observe in the conference structure? This was the first time this conference was offered. There were many strengths, including a variety of breakout sessions the students could attend. Some students did express that they wish they could have attended a certain session, but it was filled. Word of mouth regarding the more popular sessions/fun, hands on sessions spread quickly, and students chose these sessions for subsequent break out sessions. Having lunch in the same building seemed to be streamlined and cut down on time of students leaving the building to get lunch somewhere else. The conference was well planned and organized.
4. Would you like to see this conference continued in this, or a different format? If so, what suggestions do you have? Yes, please continue the conference! Suggestions: cut down on the amount of time the opening speakers had to talk with the students; this seemed to run long; possibly have students sign up for break out sessions in advance so sessions aren't overcrowded (put a cap on the number of students who can attend sessions); this could encourage students to sign up for sessions before the same day of the conference; survey the students in the planning stages of the conference to get their feedback on what they would like to see/hear/learn from the conference.

Clinical Educators' End of Semester Comments

The future impact of the iSTEM Conference on the instruction of pre-service teachers remains to be seen, yet data collected begins to show evidence of such. I am elated to share testimonies of Clinical Educators reporting evidence of the many ways the conference affected education.

Kent Robison – Gallery 2

A group of students in this Gallery sponsored a STEM Night at Zitzman Elementary in the Meramac School District for their SAIL Project. The students credited their experiences at the iSTEM Conference as inspiring and having provided guidance. At least 704 parents, students, and community members attended. There were food trucks, LEGO robotics, marshmallow bridge construction, and two performances from the Wild Bird Sanctuary. The pre-service teachers collected data on the total number of participants and favored activities. An awful lot of work was spent conducting the event, and the pre-service teachers only received 100 points towards their grade. Participants were able to purchase pieces of duct tape, which were later used to tape a teacher to the wall. This was considered a tremendous success, the principal loved the idea, and (Kent) plans to have the next group of Practicum students produce a similar project.

Karla Gerke – Gallery 7

Practicum students in Karla's Gallery have planned to conduct STEM Days for their SAIL project. It is being planned for the third grade students, and will be held during MAP from April 24-26th at Hawthorne Elementary in Fort Zumwalt School District.

Ellen Heavner – Gallery 9

In two St. Louis Public Schools and a school in Parkway, Ellen would like to have students watch the total eclipse on August 21. She is encouraging Pre-service teachers to obtain glasses, instruct students on their usage, and hold eclipse watch parties. Grants for glasses are available online.

Deanna Granger – Gallery 6

Deanna has ordered "Dream Boxes" for her children, and mentioned it to her high school Clinical Teachers. They developed an idea to have Dream Boxes for science make-up work, so students wouldn't just repeat answers given to them by friends. The students actually look forward to the surprise activities in the boxes, and enjoy the make-up work. The brainstorming led one pre-service teacher to ask Deanna if he could teach a Salsa club, putting the A in STEAM.

Jerie Rhode – Gallery 8

Jerie shared that a group of her Practicum students secured funding for a food pantry for their SAIL project. Our cohort can be very proud of the conference we presented knowing it was appreciated by the pre-service

teachers, and its' influence is reaching the classroom and beyond. As the STEM experiences of students are shared by word-of-mouth, more requests will be made for this type of learning. Hopefully, STEM education will become more widely practiced in the future. The UMSL STEM Cohort has certainly contributed to that end.

Source:

Hardrict-Ewing. (April 12, 2017). Meeting Notes. Clinical Educator Meeting, University of Missouri-St. Louis.

Executive Advisory Group Reflections

Kelly Selby, Kappa Delta Pi, Mu Iota Chapter Treasurer:

"The iSTEM conference was informative and gave me ideas that I can use in my ELA classroom and to collaborate with team teachers in making iSTEM fun for kids."

Executive Advisory Group Members

Lauren Jennifer Jones

Stephanie Matteson

Beth Maxwell

Jennifer McBride

Lisa Marie Paredes

Margaret Peeno

Peggy Margaret Ruxton

Kelly Selby

Lauren Wahle

Session Conveners

During the session, conveners introduced the session presenters, kept the session on time, and directed participants to fill out the session evaluation linked inside the iSTEM Conference Guidebook App: http://guidebook.com/g/umsl-istem2017 In case of an internet catastrophe or device power failure, we provided paper backup copies of the session evaluation forms. We thank these volunteers for helping us keep sessions on schedule, encourage participants to complete the very important evaluations, and create a fun atmosphere by awarding beads to actively engaged participants.

Jenna Alexander

Erin Casey

Daren Curry

Chris Fila

Ken Foushee

Karla Gerke

Emily Goldstein

Kathy Hamilton

Richard Hamilton

Dylan Herx

Dasha Kochux

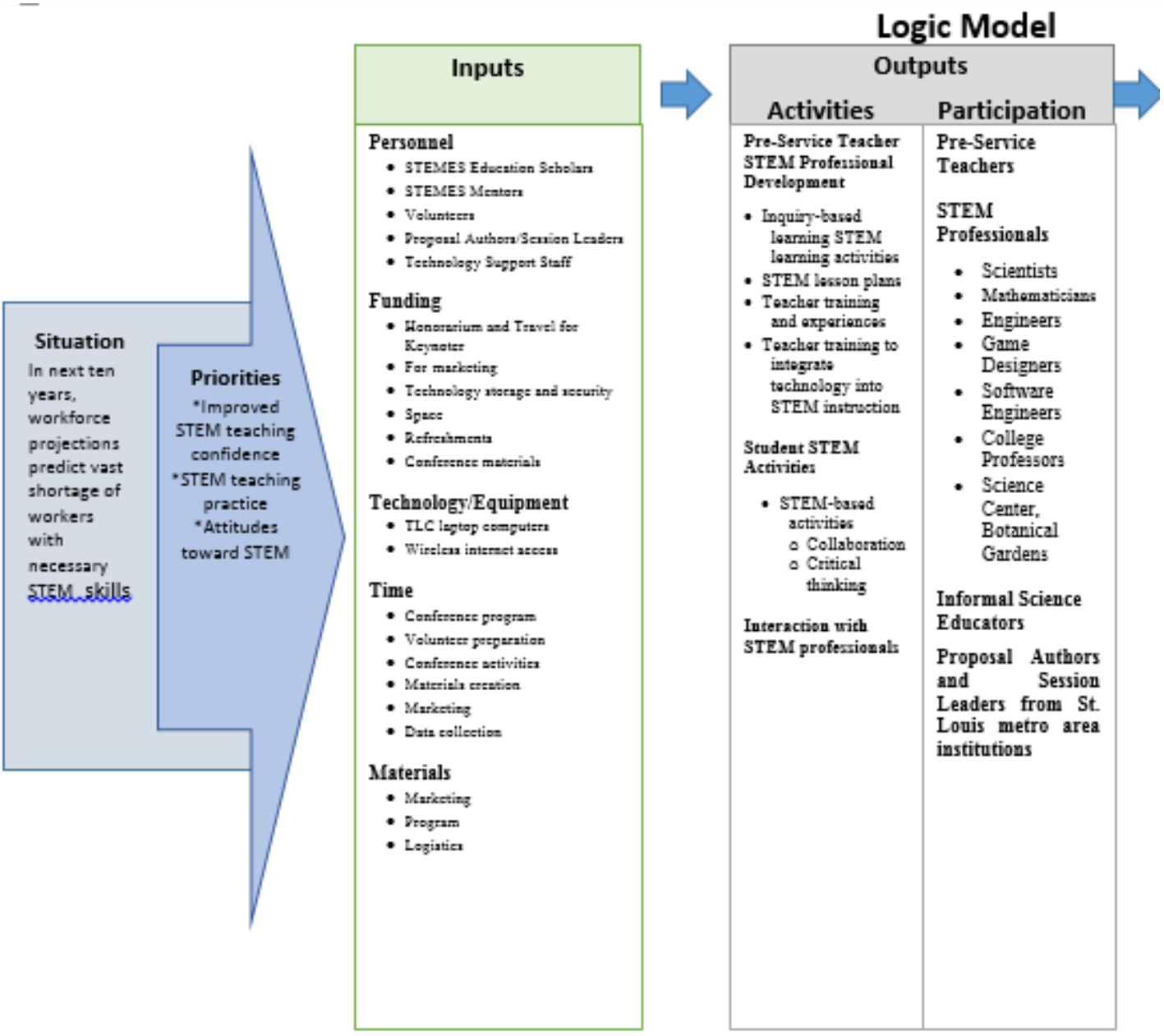
Debra Ponder

Michael Porterfield

Kristen Wilke

Appendix B

Logic Model



Outcomes - Impact

Short

Pre-Service Teachers

- Receive STEM professional development
- Acquire skills to teach STEM lessons
- Awareness of STEM career options
- Collaborate to learn and share ideas
- Improve attitudes toward STEM
- Increased interest in learning STEM
- Apply critical-thinking skills in problem-based teaching and learning
- Improve collaborative skills in teams to solve problems

Informal Educators

- Build relationships with area high schools
- Increase visibility of STEM programs in the community

Teacher Preparation Faculty and Program Leaders

- Meet to form regional STEM network
- Share research-based information on STEM education best practices

Medium

Early Career Teachers

- Integrate STEM lessons into practice
- Increased confidence and competence teaching STEM
- Improved attitudes toward STEM careers
- Join STEM professional networks
- Inspire students to consider studying STEM in college
- Design STEM problem-based activities and consider participating in competitions
- Develop and use collaborative skills across the curriculum

Teacher Preparation Faculty and Program Leaders

- Collaborate to strengthen STEM network and build repository of resources
- Develop and share STEM curricula

Long

Experience Teachers

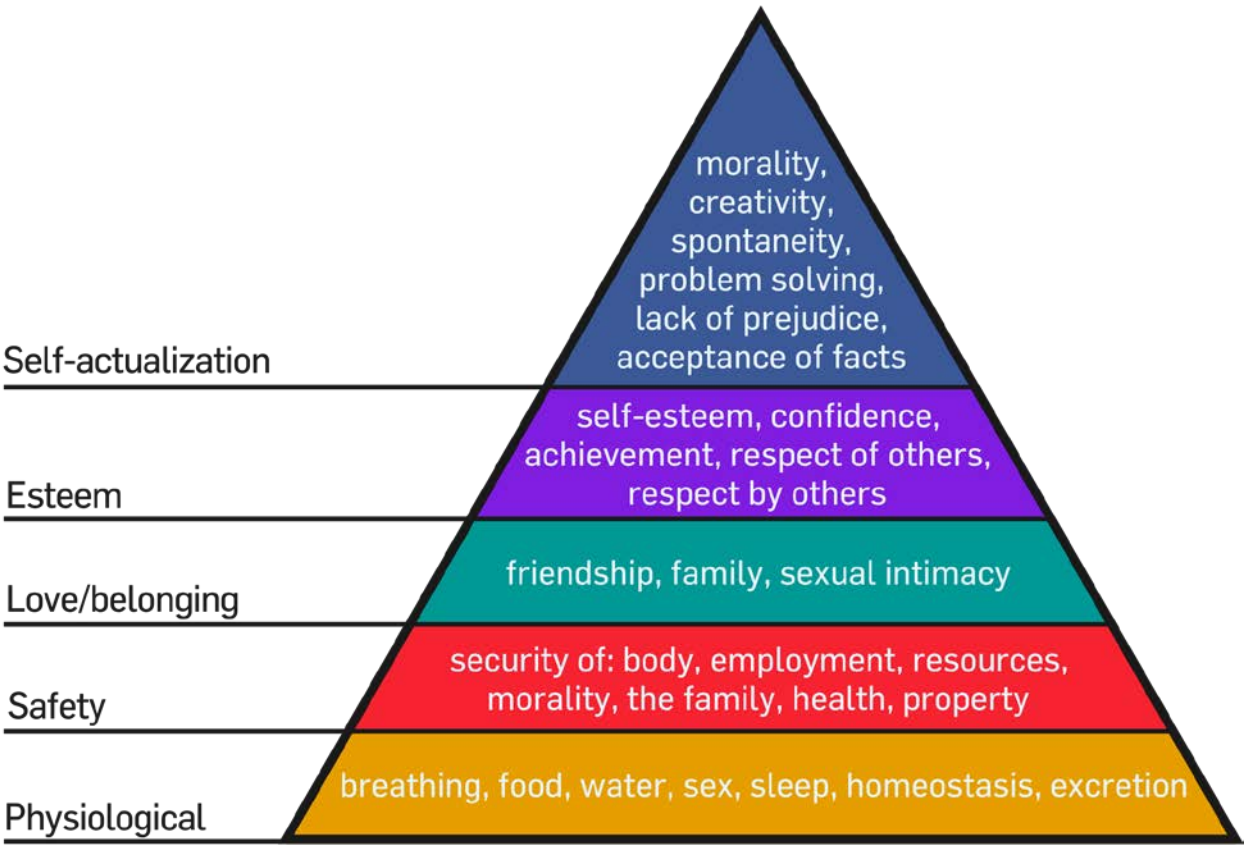
- Proficient in writing and sharing new STEM lessons with other educators
- Serve as role models and mentors for other teachers
- Serve as role models for students
- Create STEM professional networks for themselves and their students
- Inspire students to pursue STEM careers

Their Students

- Choose to major in STEM disciplines
- Pursue graduate degrees in STEM
- Use critical thinking skills to address a community problem and solve it
- Serve as mentors for younger students learning STEM
- Consider entering the STEM workforce
- Become STEM professionals and accept student interns in their practice

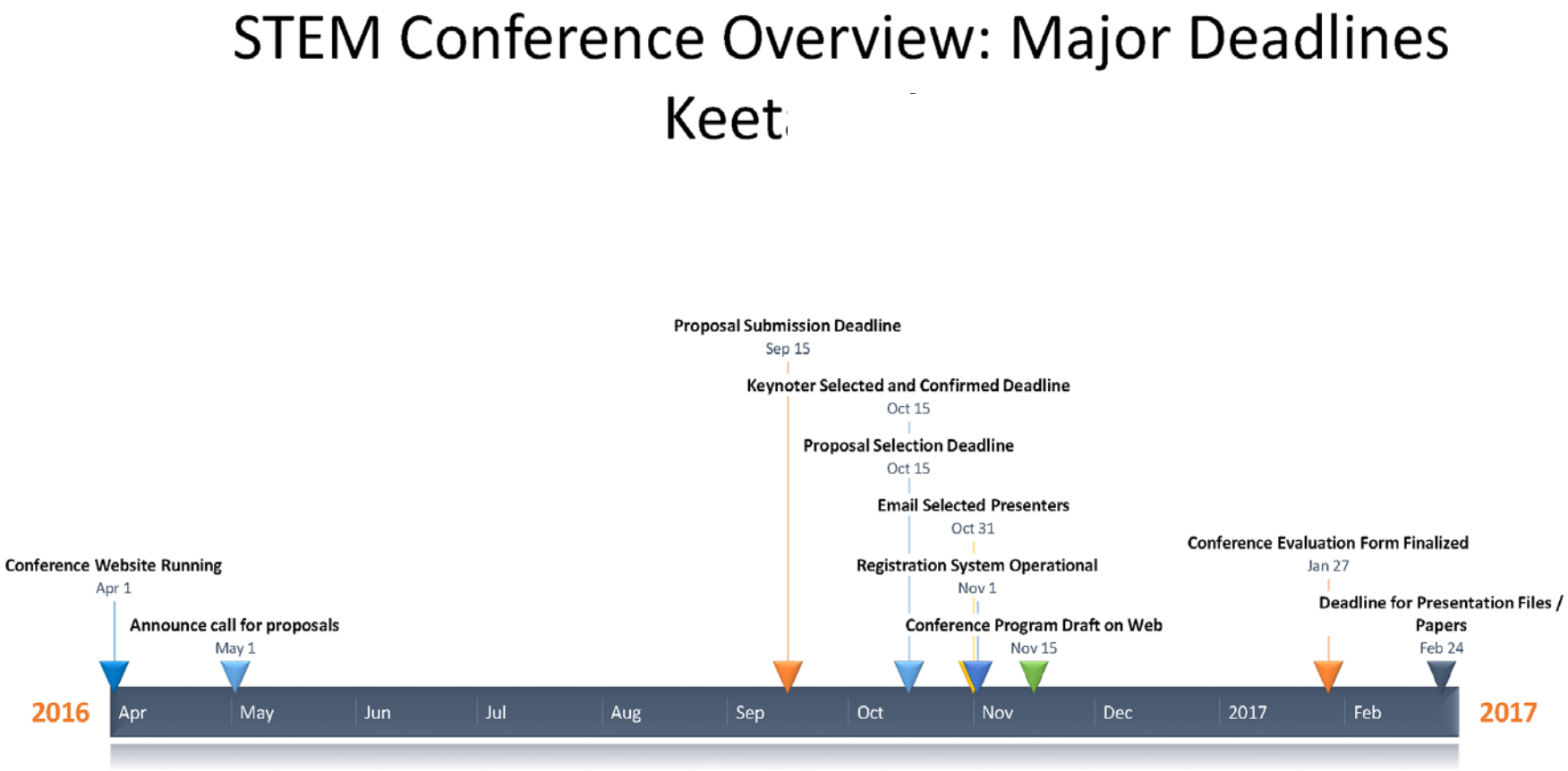
Appendix C

Maslow's Hierarchy of Needs



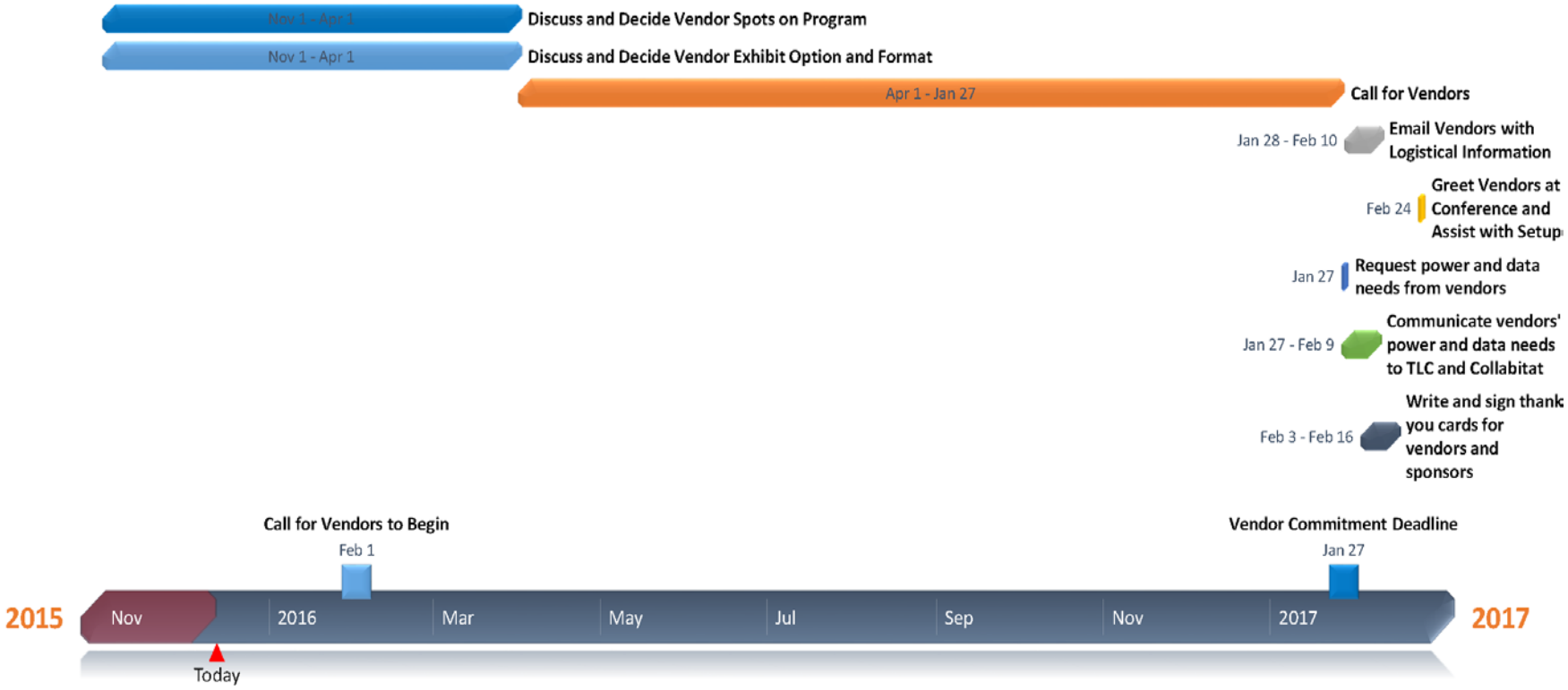
Appendix D

Conference Project Management Timelines

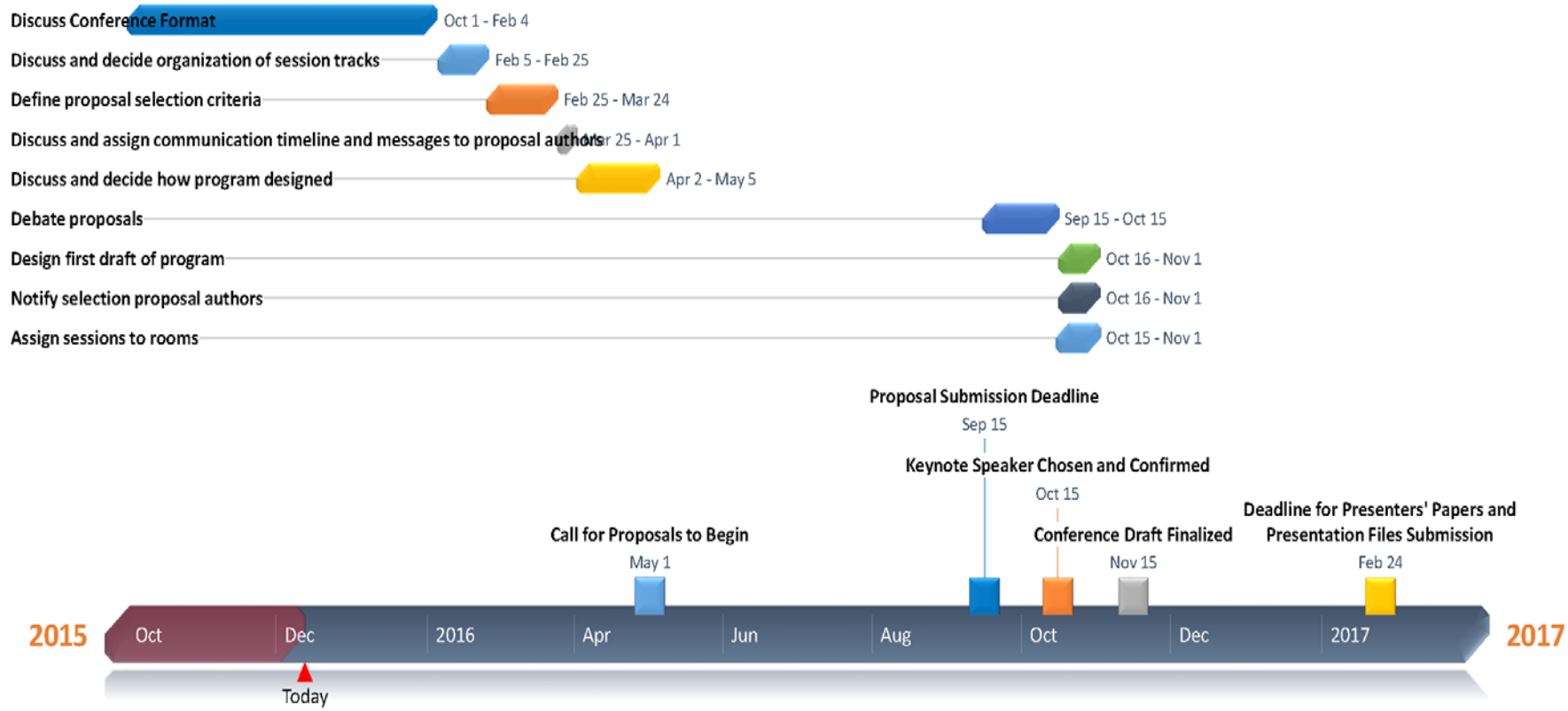


STEM Conference Overview: Timespan for Types of Work

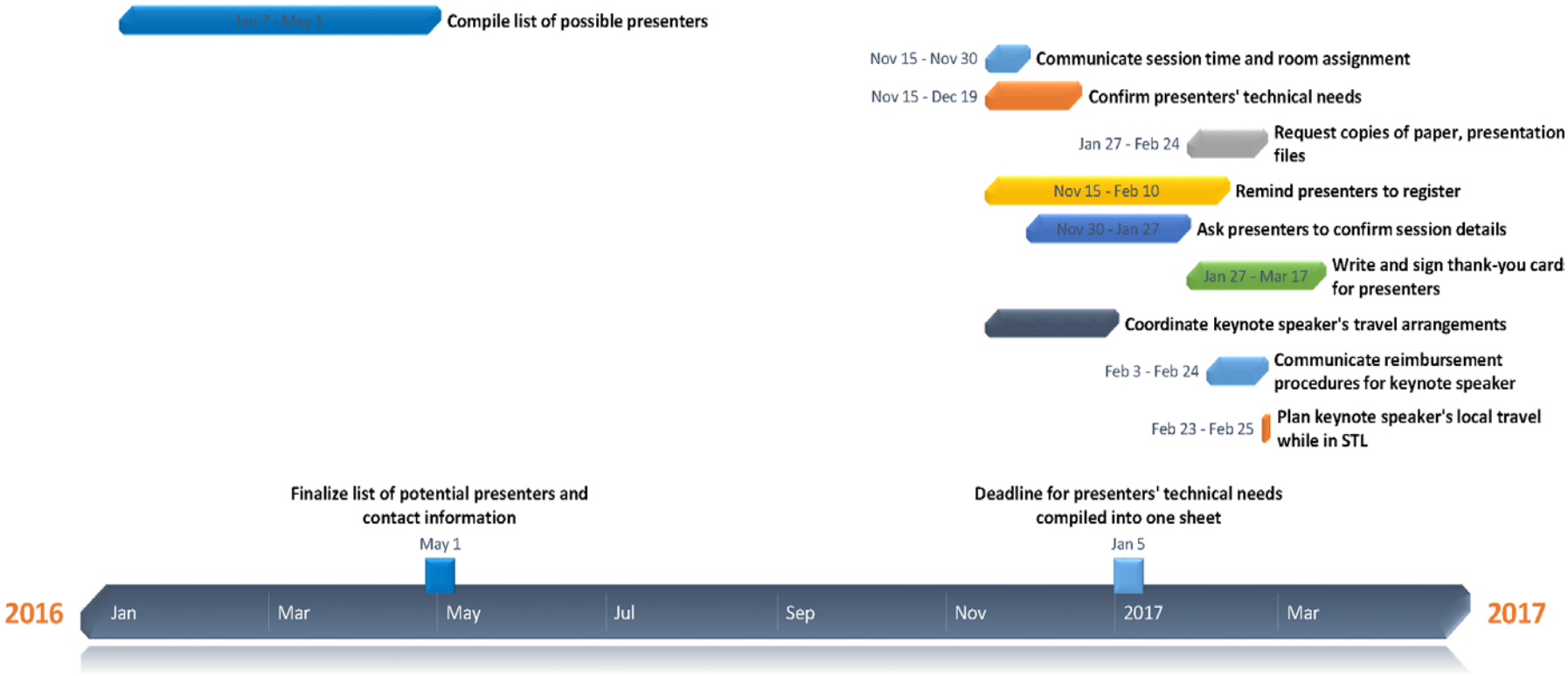
Oct 1 - Feb 1
Conference Theme Discussion and Decision
Oct 1 - Feb 1
Discuss and Decide Branding and Logo
Feb 2 - Feb 9
Write elevator speech for materials - Participants as audience
Feb 2 - Feb 9
Write elevator speech for materials - Vendors as audience
Feb 2 - Feb 9
Write elevator speech for materials - Speakers as audience
Jan 25 - Mar 1
Website Design Mockups and Feedback from Cohort
Mar 2 - Apr 1
Build Website, Finalize Design
Apr 2 - May 1
Integrate Proposal Submission Form into Website
Oct 1 - Nov 1
Integrate Conference Registration Form into Website
Sep 1 - Nov 1
Compile participant names into distribution list
Feb 5 - May 1
Compile possible speaker names into distribution list
Mar 1 - May 1
Compose Call for Proposals Media
Apr 1 - Aug 1
Choose social media tools to target audience engagement
Nov 1 - Dec 30
Design digital slideshow file for TLC and Collabitat signage
Update website with program and event chang
Conference Website Shared
Apr 1
Call for Proposals Announcement
May 1
Registration System Integrated with Web
Nov 1
Conference Program on Web
Nov 15
2015
Oct
Dec
2016
Apr
Jun
Aug
Oct
Dec
2017
2017
Today
Marketing Activities Detail



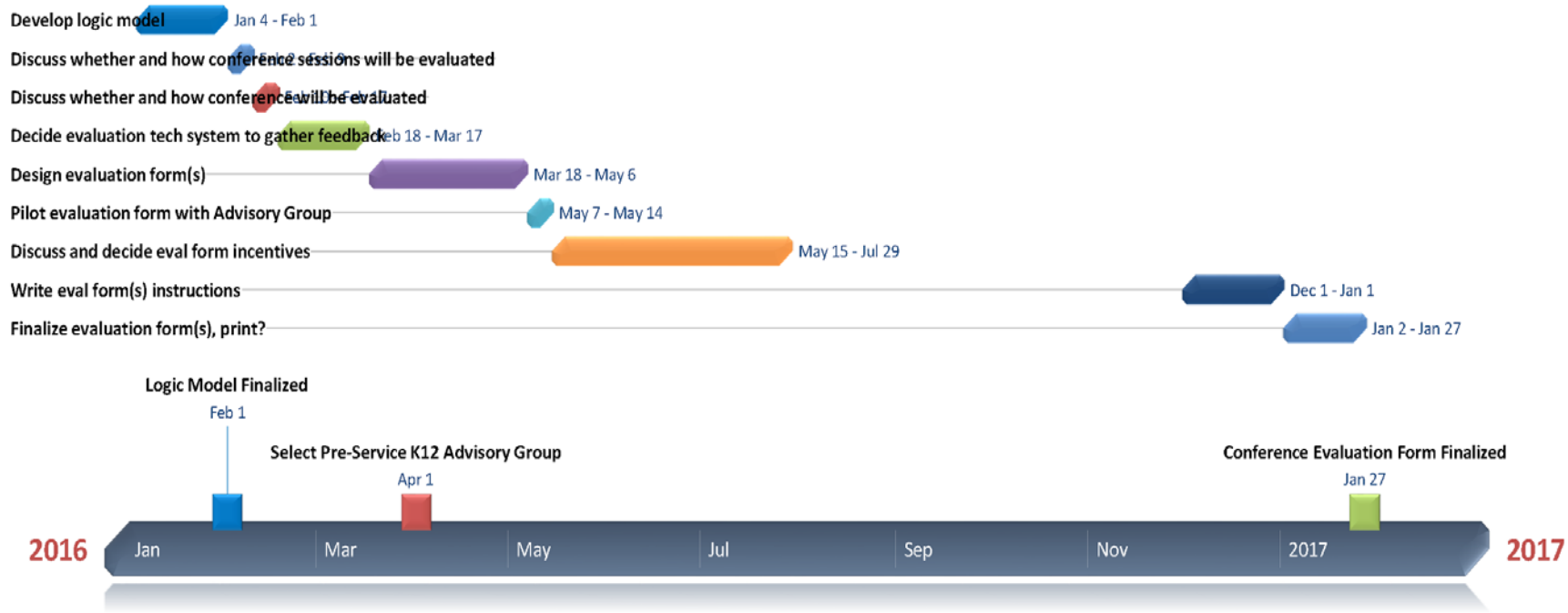
Vendor Activities Detail



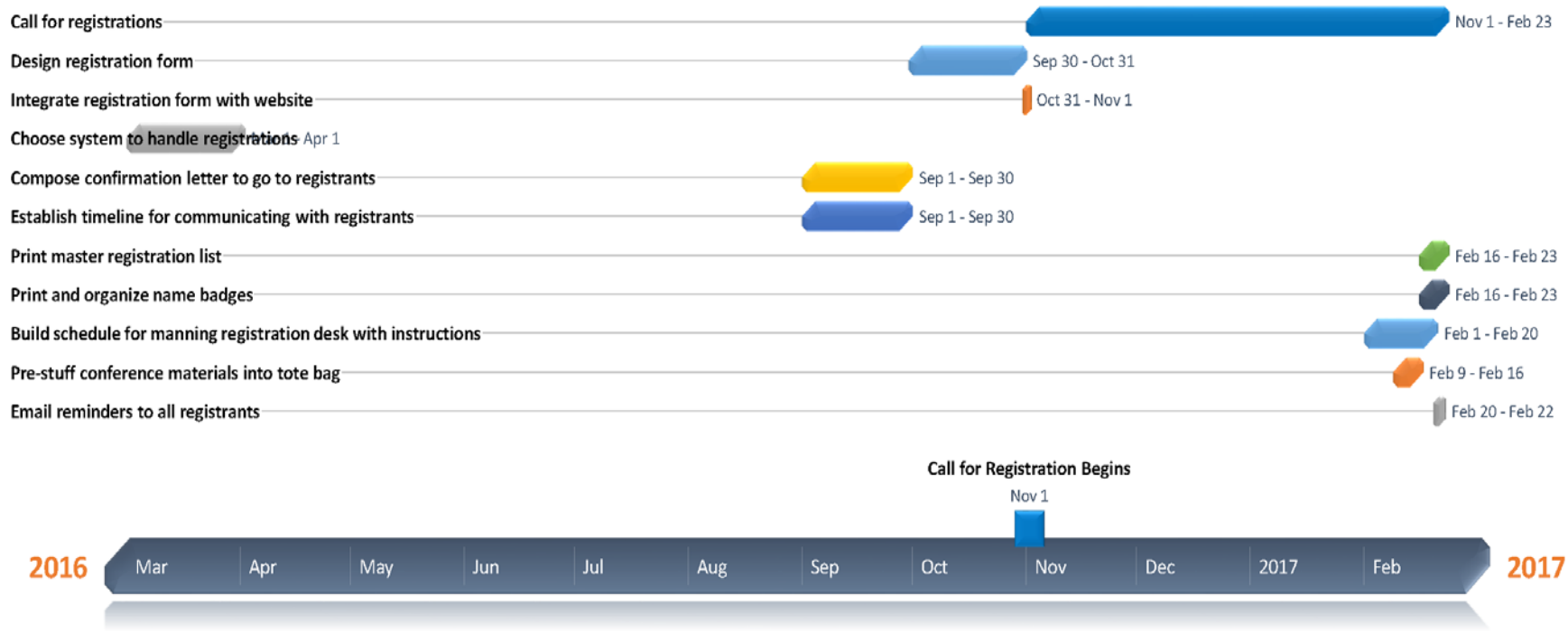
Program Design Activities Detail



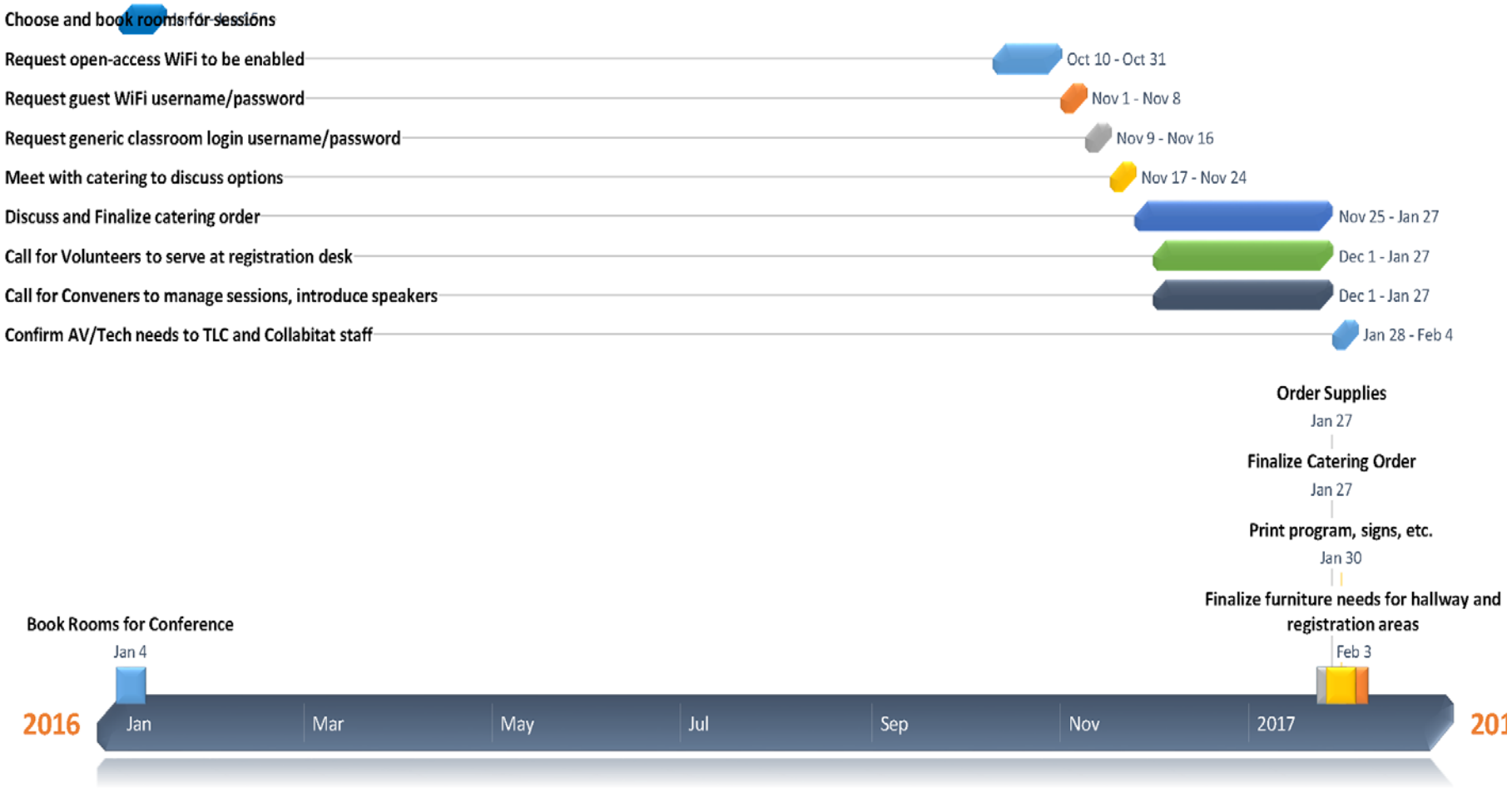
Presenter Experience - Activities Detail



Evaluation Activities Detail



Participant Activities Detail



Logistics Detail

Appendix E

Conference Evaluations

Pre and- Post Evaluative Questionnaire (Paper)

1. My familiarity with STEM education can best be described as

Not at all familiar Extremely familiar

0----------100

(please mark the slider)

2. I am confident I can integrate STEM education in my instruction.

Strongly disagree Strongly agree 0----

----------100

(please mark the slider)

3. I believe it is important for me to include STEM education in my instruction.

Strongly disagree Strongly agree 0----

----------100

(please mark the slider)

4. I define STEM as _____

_____

_____

5. I can integrate STEM education in my instruction in the following ways:

_____

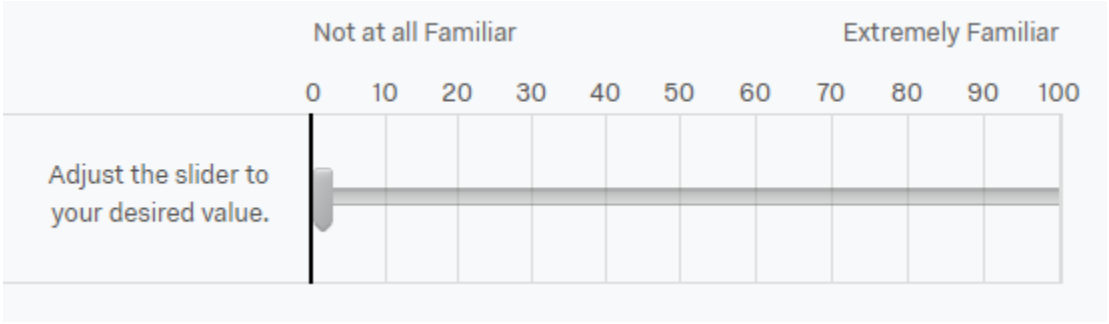
_____

_____

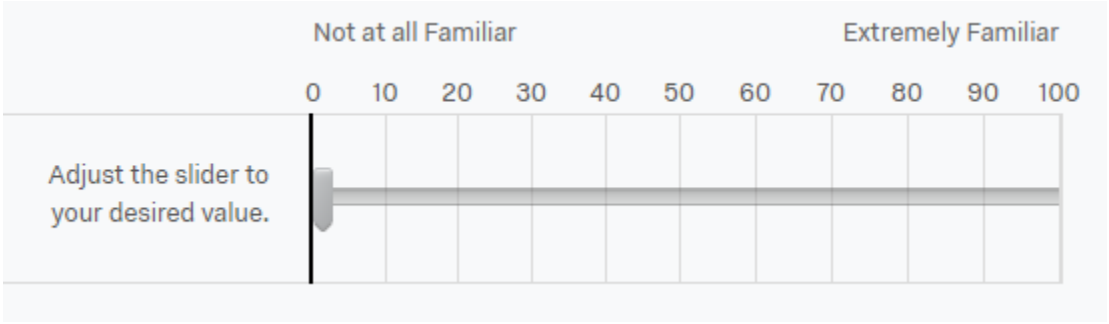
iSTEM Conference Pre-Post Evaluative Questionnaire (Qualtrics Version)

Please enter your email address. Responses will remain confidential.

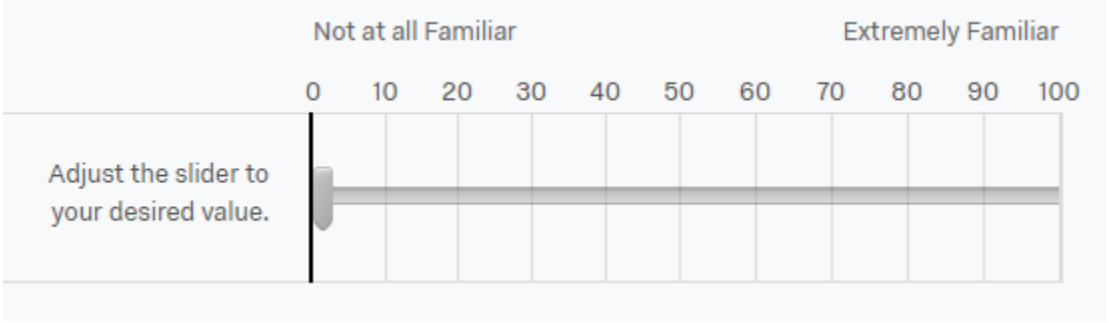
My familiarity with STEM education can best be described as
_____ Adjust the slider to your desired value.



I am confident I can integrate STEM education in my instruction.
_____ Adjust the slider to your desired value.



I believe it is important for me to include STEM education in my instruction.
_____ Adjust the slider to your desired value.



I define STEM as

I can integrate STEM education in my instruction in the following ways:

iSTEM Session - Reflective Evaluation (Paper)

1. What did you learn in this session that you would integrate in your instruction?
2. Which of the following strategies contributed to your learning (check all that apply)? ▢ direct instruction ▢ observation ▢ exploration ▢ collaboration ▢ other_____
3. In which of these "four C's" were you engaged during this session? (check all that apply): ▢ Communication ▢ Critical Thinking ▢ Collaboration ▢ Creativity
4. This session enhanced your confidence to provide STEM instruction. ____ Strongly Disagree ____ Disagree ____ Uncertain ____ Agree ____ Strongly Agree
5. I am likely to use the instructional ideas from this session with students. ____ Strongly Disagree ____ Disagree ____ Uncertain ____ Agree ____ Strongly Agree

iSTEM Session Reflective Evaluation Form

Q1 What did you learn in this session that you would integrate in your instruction?

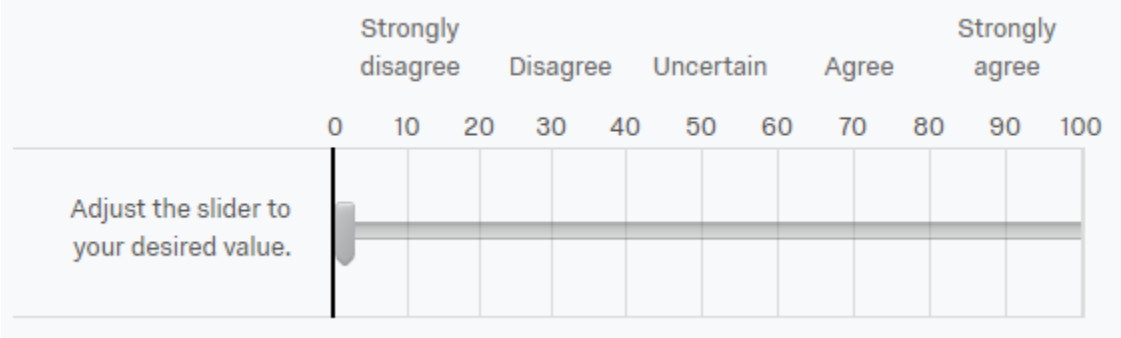
Q2 Which of the following strategies contributed to your learning? (check all that apply)

- ❑ direct instruction (1)
- ❑ observation (2)
- ❑ exploration (3)
- ❑ collaboration (4)
- ❑ other (5) _____

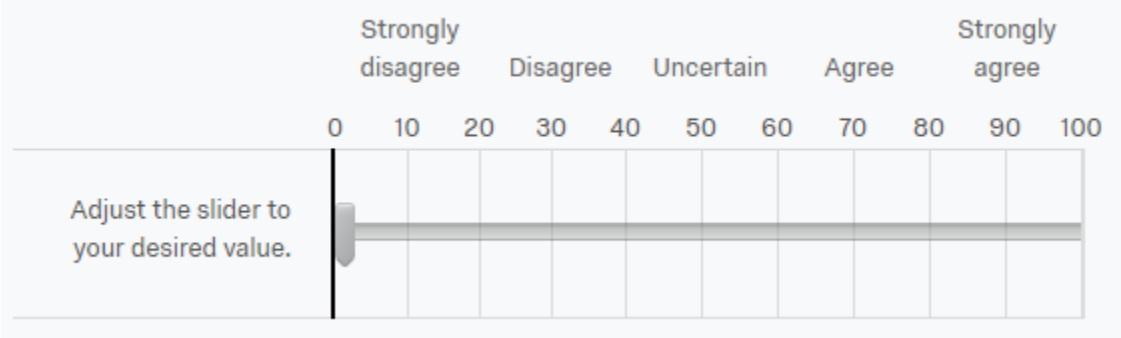
Q3 In which of these "four C's" were you engaged during this session? (check all that apply)

- ❍ Communication (1)
- ❍ Critical Thinking (2)
- ❍ Collaboration (3)
- ❍ Creativity (4)

Q4 This session enhanced my confidence to provide STEM instruction.
_____ Adjust the slider to your desired value.



Q5 I am likely to use the instructional ideas from this session with students.
_____ Adjust the slider to your desired value.



Summative Evaluation

1. Why has STEM integration become so important?

2. Based on this conference, name ways how STEM education can be integrated in your instruction.

a. _____
b. _____
c. _____
d. _____

3. Indicate to what degree each of these contributed to your learning:

A. Keynote speaker contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

B. Presentation content contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

C. Working collaboratively in sessions contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

D. Having opportunities to reflect contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

E. Active participation within session contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

F. Discussion within sessions contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

G. Discussions outside sessions contributed:
a. Not at all b. Minimally c. Satisfactorily d. Significantly e. Transformationally

H. What other aspects of this conference contributed to your learning?

_____
_____

4. What do you feel is needed to sustain what you learned in your sessions?

_____
_____

5. How essential do you feel conferences like this are to your teacher development?
a. Not at all b. Slightly c. Somewhat d. Very e. Extremely

Debriefing Session with Pre-Service Students and Clinical Educators
Interview Questions

Q1 - What would you like to discuss about the sessions you attended today?

Q2 - How will today's session impact your SAIL project?

Q3 - What do you still want to know about STEM?

Q4 - What were you aha moments? Did you observe aha moments with other participants? How do you know?

Q5 - What are some things you'd like to try when you teach? How would you use them?

Q6 - Do you have any specific burning questions about session you did not attend or that you overheard others talking about?

Q7 - Why is it important to have students communicating and sharing ideas with each other about their learning?

Q8 - What are some ways you can integrate STEM in your instruction?

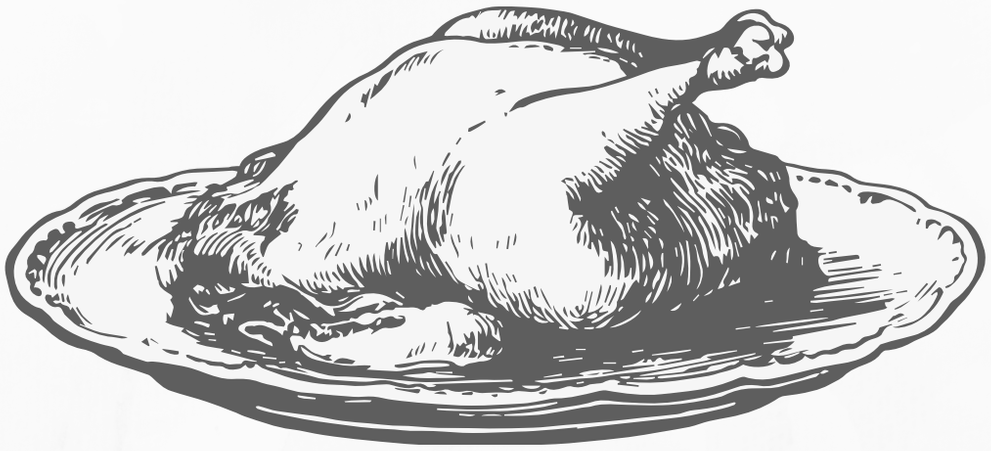
Appendix F

Guide to Gamifying your Conference

Gamifying a Conference For Educators.

Creating an atmosphere that inspires educators to love learning, adopt new ideas, and share forward

2017 STEM Educational Scholars Cohort



Key Ingredients

1 strategy for awarding beads
1 Bag of 50 Beads for each convener
1 Bag of 50 Beads for each STEM Cohort Member
1 Box of 500 Beads for Guidebook Table
1 Necklace with 1 Bead for Each Participant
2 Posters with Rules / Procedures
2 Volunteers to exchange beads for tickets
Dash of fun
Sprinkle of cheer

KEETA HOLMES

Procedures

Before the conference:
Inform all attendees about the rules of the game. Explain how to earn points early
*Filling out pre-conference survey
*Contributing to activity feed in Guidebook
*Downloading Guidebook app

Each attendee receives
At Registration desk
*A necklace
*A colorful bead

At Guidebook Table
* A colorful bead for downloading app
* A colorful bead for posting to Guidebook activity feed

At Convener Table
Each convener receives a bag of beads to distribute during the sessions:
* Gold beads are special and given to a participant who takes a chance, volunteers during a session, answers first, etc.
* Colorful beads given out to anyone for filling out evaluation, asking questions, etc.

KEETA HOLMES

Poster at Conference

HOW TO EARN BEADS

From 9:00am – 2:00pm

1. Download Guidebook iSTEM program
2. Participate in sessions
3. Discuss what you're learning in the hallways
4. Complete session evaluations
5. Share pictures on the "Learning Moments Photo Album"

Cash in your beads before 2:00 PM at the Door Prize table (JCP Lobby)

Every 5 colorful beads = 1 entry ticket

1 gold bead = 2 entry tickets

Prizes awarded at 3:15pm in the JCP Summit.
Must be present to win.

iSTEM
inform, innovate, inspire

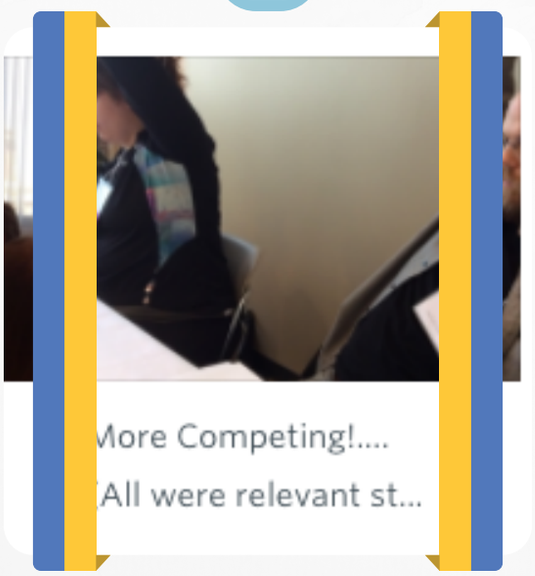
Convener Instructions

No later than 15 minutes before your session starts, please stop by the Registration desk in the JCP Lobby to pick up your convener folder and certificate of appreciation. The folder contains a reminder of your convener tasks, a set of time cards to alert the presenters when to stop, and a bag of beads to award to participants. Not all of the session rooms have a clock, so please bring a watch or mobile device to keep track of the time.

You will see you have a variety of beads to award. Please reserve enough colorful beads to give each participant a bead for completing the session evaluation. The remaining beads can be quietly awarded during the session when participants are actively engaged, asking questions, or participating in activities. You'll also notice you have at least two gold beads to be awarded to a participant for doing something special, such as volunteering to go first or sharing an especially insightful comment/question.

KEETA HOLMES

Participant Photos



KEETA HOLMES

Beads to Prize Tickets

- Every 5 colorful beads = 1 Door Prize entry ticket
- 1 gold bead = 2 Door Prize entry tickets

Write Your Name Legibly Here:

Must Be Present to Win
JCP Summit, 3:15 PM

- 3 McGraw-Hill totes with neat stuff
- 1 Travel mug set
- 1 set of 30 student whiteboards
- 2 Mini-Laminators with a set of laminating pouches
- 2 baskets of teacher stuff (stamps, clips, apple post-it dispenser)
- 2 "answer buzzers" for class use
- 2 label makers in a carrying case and label tape starters
- 1 Amazon Echo (black)

KEETA HOLMES

My Observations

As I sat at the Guidebook table, I watched as the pre-service teachers approached the Registration table across the lobby. Most participants smiled when they received both their name badge and necklace/bead. They were directed to the Guidebook table for instructions about what to do next. By the time that they arrived at the Guidebook table, the volunteers explained that throughout the day they'd earn beads for participating and sharing experiences in the Guidebook App. Nearly all participants immediately downloaded the app, took a group selfie with others nearby, and laughed at the pictures others took. Introduction to the day, app, and conference began with smiles and laughter. A small group of 5-7 young women were engrossed with earning more beads and began running around the lobby to take photos, explain to others about the game. Some students rushed to the prize table to see what they would earn. Others examined how to affix the beads to the necklace.

When participants were seated in the auditorium waiting for the opening session to begin, STEM Cohort members awarded beads to those sitting in the front rows and explained to the crowd that bravery earns beads.

KEETA HOLMES

My Observations

During the first round of concurrent sessions, I observed how the conveners quietly awarded beads to participants who raised their hands, tried an activity, answered questions, or asked questions. As soon as one student earned a bead, I saw on average 3-5 hands raise immediately afterward with smiles on their faces and eyes on the beads. As students completed their session evaluations, students didn't leave the room without getting their bead.

Throughout the hallways, students were arranging their beads in various ways and talking about their creative solutions to managing the beads with each other. I believe that this gave students something fun to talk about with each other.

When students were in line to exchange their beads for door prize tickets, over 10 students replied saying that they were reluctant to exchange their beads at all. They loved the beads and wanted to keep them and also get the door prize ticket for earning them.

The session rooms, hallways, and lunch lines were full of energy from the day, and I do believe that the beads/game contributed to this though it is difficult to measure or be sure.

KEETA HOLMES