ABSTRACT

ROSENO, ASHLEY TICE. Teacher Professional Development in Nutrition Science to Enhance STEM Education. (Under the direction of Dr. Tuere A. Bowles).

This collection of essays examines concepts related to teacher professional development (PD) curricular quality and evaluation using the base of Kirkpatrick's Four Level evaluation model, reactions, as a foundation for the research on participant's perceptions. Effective teacher PD programming aimed at preparing teachers to implement hands-on application-based STEM activities can better engage K-12 students in mathematics and science. Utilizing application-based activities where K-12 students have preexisting contextual knowledge can help combat many of the issues underrepresented minority (UM) K-12 students experience in STEM subjects. Increased UM K-12 student engagement in STEM subjects can lead to improved performance and persistence in these subjects throughout post-secondary education, thus contributing to the need for a more diverse STEM workforce. The three essays combined provide insight into factors which contribute to teacher PD curricular quality. While these three studies explore distinct research questions of varying scope, the insights derived from these studies will provide science educators with research-based education practices to better facilitate and evaluate quality teacher PD.

Essay one, *Exploring the role of in-service teacher professional development on encouraging underrepresented K-12 students to pursue careers in STEM fields: An integrative literature review,* investigated teacher professional development practices and concepts which promote careers in Science, Technology, Engineering, and Mathematics (STEM) and health sciences for underrepresented minority youth (UM). Essay two, *Validation of an in-service teacher professional development satisfaction survey,* employed a secondary data analysis to validate a teacher professional development satisfaction survey for scientist and clinician-developed STEM educator professional development programs such as those funded by National Institute of General Medical Science (NIGMS), Science Education Partnership Award (SEPA). Essay three, *In-service teacher perceptions of a food and nutrition professional development workshop*, examined secondary data to explore participant professional perceptions about the quality of a food and nutrition teacher PD through process evaluation. Methods implemented included on-site observation by a rater, post-implementation focus groups, and a post-implementation satisfaction survey. This study was aimed at providing the PD developers with research-based evaluation results to improve the design and delivery of future programming.

Formal and informal K-12 learning environments provide a unique opportunity to enrich the lives of teachers and educators, and the children and families they serve. The findings presented in these essays provide important information and resources for STEM teacher PD developers for engaging UM youth in K-12 STEM to better support the STEM career pipeline. By creating, implementing, and properly evaluating application-based hands-on teacher PD experiences aimed at preparing teachers to implement similar practices in the classroom, STEM PD developers can begin to combat the unbalanced STEM workforce by engaging UM K-12 students before it is too late.

Keywords: K-12 student, K-12 teacher, STEM, STEM career, healthcare career, biomedical science, underrepresented minority, in-service teacher professional development, process evaluation, validity, reliability

Teacher Professional Development in Nutrition Science to Enhance STEM education.

by
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A dissertation submitted to the Graduate Faculty of
North Carolina State University
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

Educational Research and Policy Analysis

Raleigh, North Carolina
2019

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DEDICATION

I dedicate this to my daughter, Avery Roseno. Never forget that you can do anything you set your mind to no matter the obstacles.

"So be sure when you step, Step with care and great tact. And remember that life's A Great Balancing Act. And will you succeed? Yes! You will, indeed! (98 and ¾ percent guaranteed) Kid, you'll move mountains." –Dr. Seuss

BIOGRAPHY

Ashley Roseno grew up in Greenville, North Carolina, and has received three degrees from East Carolina University (ECU). She received her bachelor's degree in Nutrition Science (2011) and completed her dietetic internship (2013) at ECU. Then she decided to also pursue a Master's of Science in Nutrition Science (2014) and a Master's of Education in Adult Education (2015) at ECU as well. Ashley's road toward a doctorate program was not one she envisioned during her formative years in school. She was an average student who was more interested in socializing than learning. It was not until she had graduated high school and was working full time as a veterinary technician that she had any thought about pursing higher education. At that point, she knew her grades were not the best, so she enrolled in the local community college to complete general education requirements.

At the community college, Ashley excelled in mathematics courses leading her to follow a mathematics education trajectory; however, after attending ECU, Ashley realized this was not the most appropriate path. She had been working at the student recreation center when she found a passion for nutrition. Due to the heavy biology and chemistry load, Ashley began to struggle again with school. Fortunately, she met her mentor her junior year in school and started working with the Food, Math, and Science Teaching Enhancement Resource (FoodMASTER) as an undergraduate researcher. It was with this program, she began to find her passion for teaching again, but in nutrition instead of mathematics.

Ashley began excelling in school again and even presented her summer research to ECU's Board of Trustees and North Carolina Governors after being selected as an outstanding undergraduate researcher. Once she finished her Bachelors of Science in Nutrition, Ashley began her combined Dietetic Internship and Masters of Science program while working as a graduate assistant for FoodMASTER. At this point, she had published her first manuscript in the Journal of Young Children and was working on her second as a result of her master's work. However, she loved teaching so much she decided to extend her time and pursue a Master's in Adult Education. Here she found her niche in the combination of nutrition and education.

This brings us to the present day, where Ashley is finishing her terminal degree in Adult Education. During this time, Ashley served as a faculty member in East Carolina University's Department of Nutrition Science; however, during the summer of 2019, Ashley was offered and accepted an Assistant Professor of Practice position with the Department of Health Nutrition and Exercise Sciences at North Dakota State University. In this position, Ashley also serves as the Dietitian Education Program (DEP) coordinator, which has been her goal since serving as the student representative for the Accreditation Council for Education in Nutrition and Dietetics (ACEND). During this time, Ashley realized the importance of accreditation as well as serving the profession and community by properly training and mentoring students while completing the required supervised practice hours. It is her goal to provide the students enrolled in the DEP program with quality leadership and mentorship to better prepare them to serve the community as dietetics healthcare professionals.

ACKNOWLEDGMENTS

First and foremost, I would like to thank my parents for always telling me there was something better out there, and that I should pursue my goals regardless of what other people think I can or cannot do in this world.

To my granny, who is no longer with us, I miss you with all my heart, but I know that you have been looking over me and giving me that kick in the butt when I needed it the most. I love and miss you every day.

To my husband, Steven Roseno, I would not have made it this far without our partnership. We have been down a very long and tiresome road with your medical school and residency, and then my master's, doctorate, and career pursuits all the while raising our wonderful daughter. There have been many bumps along the way, but I could not have asked for a better partner. Thank you for the continued support and belief in me all these years.

To my daughter, Avery Roseno, you have certainly made life interesting, but without you I would not be who I am today. I love you to the moon and back.

To Melani Duffrin, my mentor and best friend, if you had not seen in me what everyone else seemed to dismiss, I honestly do not know where I would be today; surely not finishing my doctorate. Words cannot express my gratitude for all you have done and continue to do for me personally, academically, and professionally.

To my Chair, Dr. Tuere Bowles, you have been there for me from day one of doctorate pursuits, and have kept me on the straight and narrow, even when I threw a few curve balls. Thank you for sticking with me and keeping me in line!

To my committee, thank you for your time, guidance, support, and understanding. A special thank you for taking extra time to work with me on my expedited timeline after my proposal defense so I could receive my job offer. I am very happy with my new position and could not have done that without you all working with me so diligently.

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CHAPTER ONE: Introduction

The purpose of this research is to discover innovative approaches to impact learning environments in the K-12 classroom by examining concepts related to teacher professional development (PD) curricular quality using the base of Kirkpatrick's Four Level evaluation model, reactions, as a foundation for the research on participant's perceptions. The three essays combined provide scientist and clinician K-12 STEM teacher PD developers with necessary information on what culminates in teacher PD curricular quality. While these three studies are distinctly different in study aims and scope, the information derived from these studies will serve to provide science educators with research-based education practices in offering and evaluating quality teacher PD. Each study is designed to address one of the following principal research questions and sub questions:

1. What K-12 teacher PD and teaching techniques and strategies are being used to engage underrepresented minority (UM) youth in STEM?
2. What is the factor structure and reliability of a researcher-developed educator professional development satisfaction survey?
3. What are the quality indicators of a hands-on, application-based STEM food and nutrition teacher PD workshop which should be maintained and what should be reconsidered in future offerings?

Background

Teacher Professional Development

Professional development (PD) has been defined as a process by which new skills or information is introduced with the intention of improved work performance (Till, Ferkins, & Handcock, 2011). Most professional development programs share a common purpose to transform professional practices, beliefs, and understanding of educators (Guskey, 2002). Specifically, a focus on improving participant learning, teacher practices, and K-12 student learning must be extant (Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010; Whitworth & Chiu, 2015). Furthermore, how teachers think and feel about a new curriculum and the implementation process are some of the strongest indicators of whether teachers will implement the curriculum (Martin, McCaughtry, Hodges-Kulinna, & Cothran, 2008).

Teacher professional development quality. Teacher professional development should include a focus on K-12 student needs and learning (Loucks-Horsley et al., 2010). Strong evidence of improvement in K-12 student learning outcomes is a key element for a significant change in teachers' attitudes and beliefs (Guskey, 2002). Creating effective teacher professional development experiences should be purposeful in aim and content as well as employ engaging methods for implementation. Based on previous research, Desimone (2009) has identified content focus, active learning, coherence, duration, and collective participation as critical features of professional development.

Methods for evaluating teacher PD quality. Evaluating PD experiences can inform improvement for future programming, determine program worth, and justify the existence of the training experience (Kirkpatrick, 1994). While there are existing validated PD evaluation instruments (Peytchev, 2009; Friday Institute, 2019), there is a gap in the research regarding teachers' thoughts and perceptions of their professional development experience (Till et al., 2011). By employing the Kirkpatrick Four Level model to evaluate teacher PD, essential information can be provided to program developers which can determine program effectiveness and usefulness. Kirkpatrick's Four Level evaluation model presents four sequential steps to evaluation, each important and necessary for determining program effectiveness: (a) reaction, (b) learning, (c) behavior, and (d) results (Kirkpatrick, 1994).

The first level, reaction, also referred to as satisfaction, measures participant thoughts and perceptions. This level is often omitted in STEM and health science PD experiences; however, it is crucial to complete each level in order before moving on to the next. If participants do not have a positive experience, they are not likely to learn the intended information or skills resulting in lack of implementation motivation or fidelity (Kirkpatrick, 1994). If learning does not occur, evaluators cannot move to the next level of evaluation, learning. PD experiences should be focused on the participants and their needs. Without collecting information regarding their satisfaction, PD developers cannot make informed improvements to programming (Guskey, 2002; Loucks-Horsley et al., 2010).

Influencing Science Career Pursuits

As K-12 students matriculate from primary to secondary education, research has shown a rapid decline in interest in STEM subjects such as science and mathematics, which has led to a decreased interest in pursuing STEM careers. K-12 student interest in and attitudes toward science vary greatly between age and gender as well as socio-economic status and cultural background (Christidou, 2011). Minority girls are among the least likely to engage in science and science-based activities (Calabrese-Barton, Tan & Rivet, 2008) with chemistry and physics being the least appealing and engaging (Christidou, 2011). These subject areas are essential for pursuit of healthcare and science careers, but with a lack of engagement at earlier ages, K-12 students are less likely to pursue careers requiring these challenging subjects (Povtin & Hasni, 2014).

Underrepresentation of Minority Groups in STEM

Underrepresented minority groups including Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives are underrepresented in STEM careers creating a topic of concern for researchers (National Science Foundation (NSF), 2019). According to the U.S. Department of Commerce (2017) employment in STEM professions increased by approximately 14 percent more than non-STEM professions (24.4 percent versus 4.0 percent, respectively). In fact, STEM professions are expected to grow by almost nine percent from 2014 to 2024 as compared to the approximate six percent growth for non-STEM professions; however, minority groups account for only about 17 percent of the STEM workforce. Almost 70 percent of all scientists and engineers are White with Asians accounting for 13.5 percent, Blacks or African Americans at 7.7 percent, Hispanics or Latinos at 8.6 % percent and American Indians or Alaska Natives 0.3 percent (NSF, 2019). When compared to the U.S. population, the numbers are very different with White (not Hispanic or Latino) accounting for 60.4 percent, Asians 5.9 percent, Blacks or African Americans 13.4 percent, Hispanics or Latinos 18.3 percent, American Indians or Alaska Natives 1.3 percent (United States Census Bureau, 2018).

Program Description

The FoodMASTER Initiative is a compilation of curricula rooted in constructivist learning theory, building on the learner's preexisting contextual knowledge through hands-on experience, environment manipulation, and reflection (Piaget, 1973). FoodMASTER began with a partnership between a nutrition science faculty member and an elementary school teacher at Ohio University. The initial lessons led to the creation of a National Institute of General Medical Sciences (NIGMS) Science Education Partnership Award (SEPA) funded Initiative that now encompasses free integrative, hands-on curricula for grades three to five, six to eight, and for higher education.

The concept behind using food as a teaching tool was to provide K-12 students with a hands-on, real-word method for learning challenging subjects. Food allows for an interdisciplinary approach to learning concepts in a variety of scientific subjects including biology, chemistry, microbiology, nutrition, and health, as well as in learning mathematics concepts such as numbers and operations, algebra, geometry, measurement, and problem solving (Carraway-Stage, Hovland, Ochab, Diaz, & Duffrin, 2014; Hovland et al., 2013; Roseno, Carraway-Stage, Hoerdemann, Diaz, & Duffrin, 2015).

Program Theory

Using food and nutrition science as an integrative approach to learning in the K-12 education system provides an ideal mode of instruction for UM students. Nutrition science is grounded in biology, chemistry, mathematics, microbiology, and health providing a real-world interdisciplinary approach to learning for K-12 students (Carraway-Stage et al., 2014; Hovland et al., 2013; Roseno et al., 2015) as compared to biomedical sciences aimed at engaging post-secondary students in application-based learning using the human body and health as a premise for understanding biology (Smedley, Colburn, & Evans, 2001). These pipelines serve to provide an outlet for students to engage in STEM through health science professions; however, current K-12 efforts are not successful at engaging and encouraging UM students to purse these professions as careers. Table 1.2 outlines descriptions of these areas.

Table 1.1
Interdisciplinary Descriptions

Component	Description
Underrepresented minority (UM)	A term used to describe minority populations which are underrepresented in STEM professions. These groups include Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives (Estrada et al., 2016; National Science Foundation [NSF], 2019). STEM fields are expected in increase by nine percent by 2024; however, minorities only account for 17 percent of STEM professionals (U.S. Department of Commerce, 2017).
STEM	Biomedical and health science disciplines are rooted in Science, Technology, Engineering, and Mathematics (STEM) subjects.
Health Professions	Health professions encompass a wide range of practitioners including, but not limited to physicians, dentists, physician assistants, nurses, physical therapists, occupational therapists, registered dietitians, and speech and language pathologists.
Nutrition Science	Defined as the science of food including nutrients and substances and how they interact with the body in relation to health and disease. Nutrition science is rooted in mathematics, chemistry, biology, and social sciences (Byrd-Bredbenner, Moe, Beshgetoor, Berning & Kelly, 2014).
Biomedical Science	Biomedical science is the study of biology in the context of healthcare. It uses health and the human body as an application for biology making this discipline real-world and application-based (Smedley et al., 2001).
STEM Education	A term used to describe and interdisciplinary approach to education. STEM education integrates four subject areas into a cohesive curriculum using real-world application (Gonzalez & Kuenzi, 2012).
Partnership	In the context of this collection of essays, a partnership is defined as a relationship between scientists or clinicians and teachers. We are attempting to bridge the gap between research and practice by creating these partnerships to better prepare teachers to utilize hands-on, application-based activities considered engaging to UM K-12 students.
Professional Development	PD is a process by which new skills or information is introduced with the intention of improved work performance (Till et al., 2011). Most professional development programs for educators share a common purpose to transform professional practices, beliefs, and understanding (Guskey, 2002). Specifically, teacher professional development should focus on improving teacher learning, teacher practices, and student learning (Loucks-Horsley et al., 2010; Whitworth & Chiu, 2015).

The current STEM workforce greatly lacks diversity, especially in health science professions which results in minority populations not being adequately served. Cultivating a more diverse population of health professionals will increase cultural competency, provide greater access for minority patients, and increase health care administrator knowledge about diverse populations which will advance responsiveness to their needs (Beach et al., 2005). Currently, 15 to 20 percent of the population in the U.S. is living in an area where healthcare is inadequate with an almost 15 percent deficit between the patient to physician ratio when comparing rural to urban areas (Hing & Hsiao, 2012). Seeing as many of the individuals living in rural areas are a member of what is considered a minority group, there is not only a general need for more healthcare providers, but also a greater need for underrepresented minority practitioners to better serve those populations (Komaromy, 1996; Milem, 2003; Saporu, 2015). To encourage UM individuals to pursue these professions more efforts need to be made with K-12 students to better engage them in STEM subjects needed to be successful in post-secondary educational pursuits of health science professions (Perry, Link, Boelter, Leukefeld, 2012). Employing an interdisciplinary approach to teaching can bridge this gap for UM students. The FoodMASTER Initiative attempts to do this using multiple elements as described here:

Underrepresented minority (UM). UM is a term used to describe minority populations which are underrepresented in STEM professions. These groups include Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives (Estrada et al., 2016; NSF, 2019). STEM fields are expected in increase by nine percent by 2024; however, minorities only account for 17 percent of STEM professionals (U.S. Department of Commerce, 2017).

STEM. Biomedical and health science disciplines are rooted in Science, Technology, Engineering, and Mathematics (STEM) subjects. To pursue health science careers, K-12 students need to be successful in STEM subject areas before attending post-secondary education (Povtin & Hasni, 2014).

Health professions. These professions encompass a wide range of practitioners including, but not limited to physicians, dentists, physician assistants, nurses, physical therapists, occupational therapists, registered dietitians, and speech and language pathologists. Access to health professionals is currently a larger issue for minority individuals considering the current Medicare-eligible population continues to grow; however, minority groups account for a small portion of the current health science professionals (National Hispanic Health Foundation, 2013). Given that minority physicians are more likely to serve minority populations, it essential to engage minority K-12 students in science and mathematics to spark interest in STEM health professions (Fleischer, Wemhoff, Obrien, Ural, & Alaways, 2010; Milem, 2003; Williams & Rucker, 2000; Institute of Medicine, 2002).

STEM education. A term used to describe and interdisciplinary approach to education. STEM education integrates four subject areas into a cohesive curriculum using real-world application (Gonzalez & Kuenzi, 2012). These subject areas are essential for pursuit of health science careers, but with a lack of engagement at earlier ages, K-12 students are less likely to pursue careers requiring these challenging subjects (Povtin & Hasni, 2014).

Nutrition science. Defined as the science of food including nutrients and substances and how they interact with the body in relation to health and disease (Byrd-Bredbenner et al., 2014). Nutrition science is rooted in mathematics, chemistry, biology, and social sciences providing a real-world interdisciplinary approach to learning for K-12 students (Carraway-Stage et al., 2014; Hovland et al., 2013; Roseno et al., 2015).

Biomedical science. Uses health and the human body as an application for learning biology making this discipline real-world and application-based for undergraduate students (Smedley et al., 2001).

Partnership. In the context of this collection of essays, a partnership is defined as a relationship between scientists, or clinicians, and teachers. We are attempting to bridge the gap between research and practice by creating these partnerships to create and implement PD experiences which will prepare teachers to utilize hands-on, application-based activities considered engaging to UM K-12 students.

Professional development. PD is a process by which new skills or information is introduced with the intention of improved work performance (Till et al., 2011). Most professional development programs for educators share a common purpose to transform professional practices, beliefs, and understanding (Guskey, 2002). Specifically, teacher professional development should focus on improving teacher learning, teacher practices, and student learning (Loucks-Horsley et al., 2010; Whitworth & Chiu, 2015).

FoodMASTER Professional Development Program Description.

The FoodMASTER (FM) food and nutrition professional development experience, a six-hour workshop, was held at Benedictine University in Naperville, Illinois on March 1, 2019. See Table 1.1 for the workshop agenda with topic descriptions and time needed for each component. The FM Director (FMD), Melani Duffrin, and a consultant, the author, were the workshop hosts with an undergraduate nutrition and dietetics student serving as the workshop observer. DuPage County teachers were invited to attend the free workshop as a part of their annual Institute Day where they were provided with the opportunity to attend professional development experiences during regular school hours.

The workshop was open for attendance beginning at 7:30 AM where teachers were required sign in using the official Institute Day record log. Teachers needed to include their name, signature, and arrival time. Teachers were also provided with a folder at registration which included their materials for the day in the order based on the schedule. All recipes, instructions, and any additional necessary information were included in this folder.

The official workshop began promptly at 8:00 AM and continued until 2:00 PM. The FMD began by providing an overview of the program and its curricula as well as acknowledged and described NIGMS' SEPA support. The FMD was the primary host for the day, with the author as support during hands-on activities and when clarifying questions regarding previous classroom implementation arose. The author was the FoodMASTER program coordinator during the middle school implementation and testing phase. She attended all classroom observations to test implementation fidelity; therefore, she was able to provide a unique perspective to teachers when questions arose regarding potential issues in the classroom.

Table 1.2

FoodMASTER FAN Workshop Agenda

Time	Topic	Description	Time Needed
8:00 – 8:20 AM	Introduction	**Presentation(s):** Overview of the program, acknowledgement, and resources. **Activities:** None	20 minutes
8:20 – 8:55 AM	Food Safety	**Presentation(s):** Food safety background and concepts; locating food safety concepts in FoodMASTER curricula. **Activities:** Glo-germ – explore hand washing effectiveness.	35 minutes
8:55 – 9:45 AM	Weights & Measures	**Presentation(s):** Weights and measures background and concepts (including proper measurement); locating weights and measures concepts in FoodMASTER curricula. **Activities:** *No bake cookie* – explore how to properly measure a recipe using weight and volume.	50 minutes
9:45 – 10:50 AM	Vegetables	**Presentation(s):** Vegetables and pigment background and concepts (including acid and base application); locating vegetable and pigment concepts in FoodMASTER curricula. **Activities:** *Vegetable consumption checklist* –review a list of vegetables to indicate your familiarity with and consumption of listed vegetables. *Vegetable preparation* – test your vegetable slicing skills and knowledge by applying various vegetable preparation techniques to vegetables which can be added to a salad. *Supertasters* – learn about supertasters and test your supertaster ability using a PTC test strip.	65 minutes
10:50 – 11:00 AM	Break		
11:00 – 11:45 AM	Fats & Oils	**Presentation(s):** Fats and oils background and concepts (including emulsifiers and scientific terminology); locating fats and oils concepts in FoodMASTER curricula. **Activities:** *Lava lamp* – using oil, water, and food coloring to make a lava lamp demonstrating emulsification. *Salad dressing* – prepare an oil and vinegar salad dressing with an emulsifier to further demonstration emulsification and use salad dressing to eat the vegetables prepared in the vegetable preparation activity.	45 minutes
11:45 AM – 12:15 PM	Food Science in the Classroom (Lunch)	**Presentation(s):** None **Activities:** Brainstorming ideas about using food in the classroom and FoodMASTER while eating lunch.	30 minutes

Table 1.2 (continued)

12:15 – 1:05 PM	Grains	**Presentation(s):** Grains background and concepts (including grain anatomy and popular concepts such as gluten); locating grain concepts in FoodMASTER curricula. **Activities:** *Rice tasting* – taste the difference between whole grain brown rice and refined white rice. *Snack mix* – make a gluten-free Chex © snack mix.	50 minutes
1:05 – 1:50 PM	Group Discussions	**Presentation(s):** None **Activities:** Group discussions and brainstorming about professional development. Discussions include feedback from everyone about the FoodMASTER FAN PD workshop and PD experiences in general. The goal is to learn about effective PD experiences and how FoodMASTER can improve upon its PD programming.	45 minutes
1:50 – 2:00 PM	Closing	**Presentation(s):** Summarize the workshop and answer and lingering questions. Thank you for attending! **Activities:** None	10 minutes

The day was comprised of topic backgrounds being introduced to provide teachers with the necessary nutrition-based knowledge to carry out the hands-on activities. Topics covered included food safety, weights and measures, vegetables, fats and oils, and grains. After each brief introduction to the subject, approximately 10 minutes of lecture, teachers were engaged in hands-on activities as if they were their students. During and after completion of the activities, teachers were encouraged to discuss how the activities would or would not work in their classrooms.

To provide teachers with the opportunity to mimic a typical school day, the FoodMASTER team included lunch as part of the learning process by engaging teachers with discussion about how they could implement the morning's activities in their classroom. After lunch, the FM team completed the day's activities with grains and engaged teachers in discussions on the events of the day to receive teacher feedback regarding their satisfaction with the experience, suggestions for improvement, and their plans for implementing FM in their classrooms. This time was used as a debriefing to collect meaningful data in the form of focus groups. Teachers who did not provide consent to participate in the focus groups were provided with an alternative group discussion on the same topics to provide a collaborative environment.

Once discussions were complete, the FMD thanked teachers for attending, welcomed any final questions or concerns, and asked consenting teachers to fill out the satisfaction survey. Teachers signed out stating their end of day time on the sign-in sheet completing the day's events.

FoodMASTER PD Logic Model

The overall scope of the FoodMASTER PD experience is outlined in its logic model. The FoodMASTER PD workshop was held during the 2019 Dupage County Illinois Teacher Professional Development Institute Day. The workshop was designed as a six-hour continuing education experience for K-12 educators which introduced the broad scope of the FoodMASTER Initiative, free resources to teachers, and content specific lessons that included food safety, weights and measures, vegetables, fats & oils, and grains.

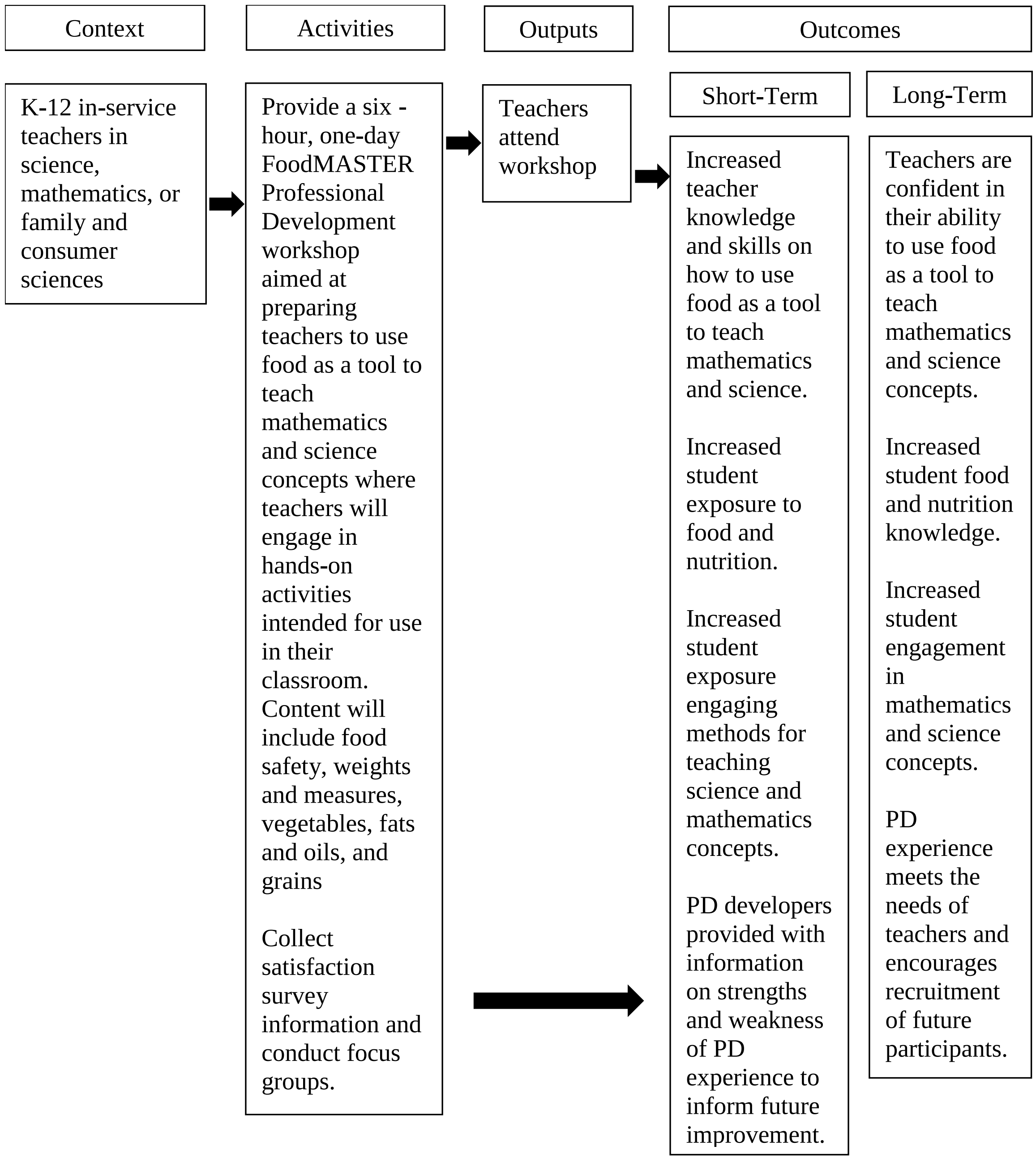

Figure 1.1 FoodMASTER professional development logic model

Context. K-12 in-service mathematics, science, or family and consumer science teachers are the target audience for this PD workshop. Teachers with a background in these topic areas are better prepared to implement the FoodMASTER activities in their classrooms.

Activities. The FoodMASTER PD experience provides a workshop for teachers to encourage the use of food as a tool to teach mathematics and science concepts. The workshop covered the broad scope of the FoodMASTER initiative, provided free resources to teachers, and shared content specific lessons which include food safety, weights and measures, vegetables, fats & oils, and grains.

Prior to the workshop beginning, teachers were asked to participate as research subjects in evaluating the workshop. Participating teachers received oral and written informed consent documents to be included in the study. All data collection procedures and documents were approved by the Northern Illinois University Institutional Review Board. Teacher participation in the study was completely voluntary and was not a requirement for participating in the FoodMASTER teacher PD workshop. Consenting teachers were provided with the satisfaction survey after completion of the workshop and asked to participate in focus groups.

Outputs. The primary output of this PD workshop is teachers physically attending the workshop.

Outcomes. Short-term outcomes are related to increased participant knowledge and skills as a result of participating in the training, and a gain in PD developer knowledge regarding teacher needs and satisfaction for future programming. Long-term outcomes are related to the participants' ability to implement the knowledge and skills acquired as a result of the training resulting in improved student outcomes, and the PD developers' ability to meet the needs of teachers and encourage recruitment of future participants. These outcomes will most likely occur at least one-month post-implementation when the participants have been provided with numerous opportunities to apply the knowledge and skills gained. K-12 students are exposed to the intervention when workshop participants implement workshop concepts in their classroom.

The program theory assumes preparing teachers to use food as a tool in the classroom setting will increase participant knowledge and self-efficacy with the anticipated long-term result of increased K-12 student engagement in mathematics and science concepts.

Dissertation Logic Model

The logic model for this dissertation provides the justification and methodology for the overall goal of the three essays.

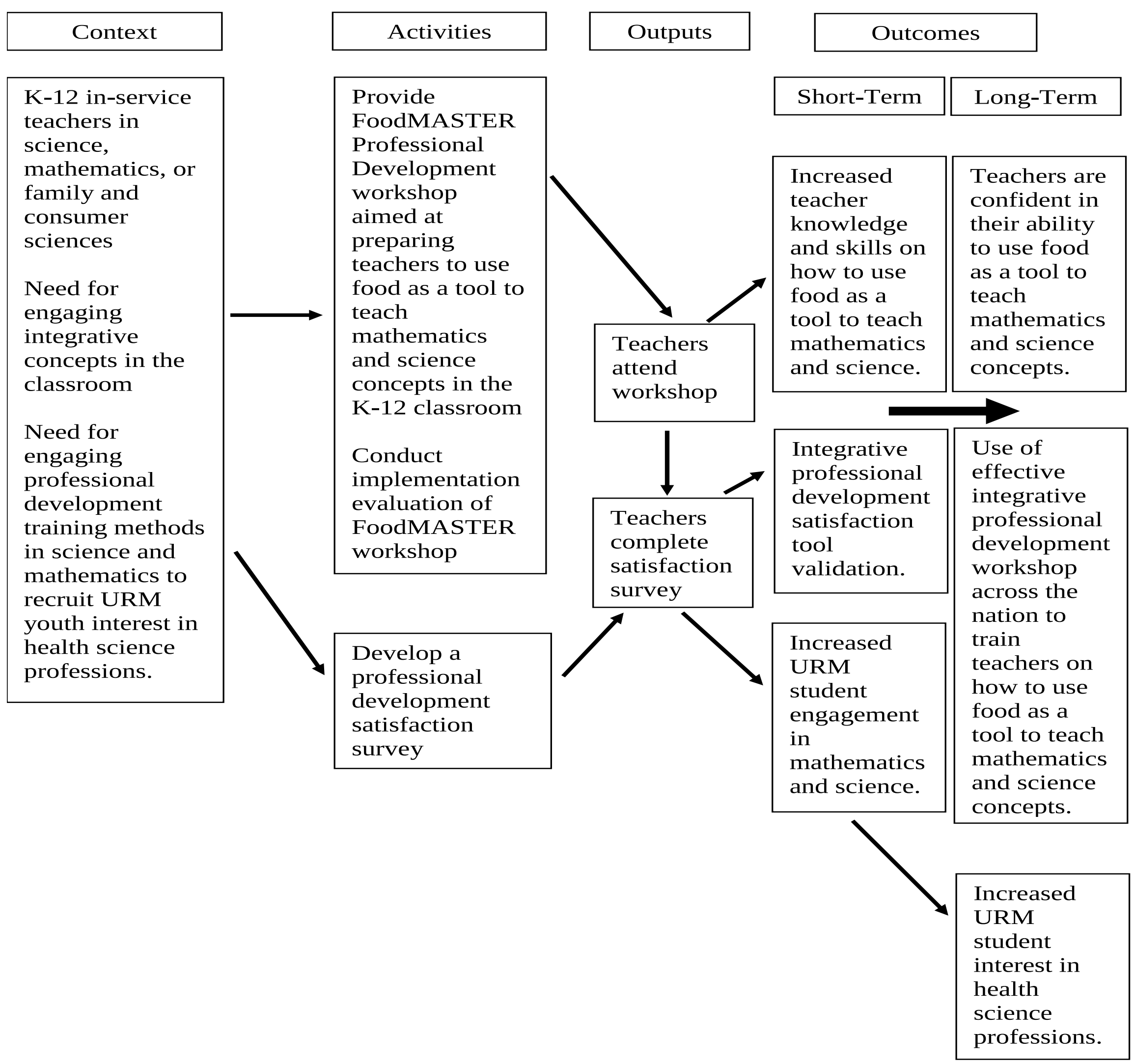

Figure 1.2 Dissertation Logic Model

Context. K-12 in-service mathematics, science, or family and consumer science teachers are the target audience. Teachers with a background in these topic areas are better prepared to implement the FoodMASTER activities in their classroom.

Activities. The FoodMASTER PD experience provided a workshop for teachers to encourage the use of food as a tool to teach mathematics and science concepts. The workshop covered the broad scope of the FoodMASTER initiative, provided free resources to teachers, and presented content specific lessons which included food safety, weights and measures, vegetables, fats & oils, and grains. An educator PD satisfaction evaluation tool was piloted at the 18th Annual K-12 Summer Institute for STEM educators to collect participant satisfaction regarding these teacher PD experiences.

Outputs. The primary outputs of this collection of essays were for teachers to physically attend the FoodMASTER workshop and for participants attending the 18th Annual K-12 Summer Institute for STEM educators to complete the satisfaction tool.

Outcomes. Short-term outcomes are related to increased participant knowledge and skills as a result of participating in the training, and a gain in PD developer knowledge regarding teacher needs and satisfaction for future programming. Long-term outcomes are related to the participants' ability to implement the knowledge and skills acquired as a result of the training resulting in improved K-12 student outcomes, and the PD developers' ability to meet the needs of teachers and encourage recruitment of future participants. These outcomes will most likely occur at least one-month post-implementation when the participants have been provided with numerous opportunities to apply the knowledge and skills gained. K-12 students are exposed to the intervention through the workshop participants implementing workshop concepts in his or her classroom. The program theory assumes preparing teachers to use food as a tool in the classroom setting will increase participant knowledge and self-efficacy with the anticipated long-term result of increased K-12 student engagement in mathematics and science concepts. An increased engagement in mathematics and science concepts can help to encourage interest from UM to pursue health science STEM professions by creating a more conducive learning environment (Christidou, 2011; Povtin & Hasni, 2014).

Chapter Overview

Chapter Two, *Exploring the role of in-service teacher professional development on encouraging underrepresented K-12 students to engage in science and mathematics: An Integrative Literature Review,* is the first of three essays in this collection. This essay explored teacher PD and concepts which promote careers in health sciences for underrepresented minority (UM) youth. The study utilized Whittemore and Knafl's (2005) methodology strategies for conducting an integrative review. This integrative review of literature provides scientists who offer teacher PD with insight into what constitutes quality teacher PD strategies and how leveraging these strategies could assist teachers in helping UM youth pursue careers in health and biomedical sciences.

Chapter Three, *Validation of an in-service teacher professional development satisfaction survey* is the second essay in this collection. This essay discusses the secondary data analysis of the design and validation a teacher PD satisfaction survey which can be utilized across the National Institute of General Medical Science (NIGMS) and Science Education Partnership Award (SEPA) teacher PD programs. The survey was developed with NIGMS SEPA teacher PD focused principal investigators' input and contains items which can be utilized across programs. The tool was piloted within the NIGMS SEPA funded Model Education Networks to Optimize Rural Science (MENTORS) program. This program offers a teacher institute which invites a wide variety of teacher PD programs to offer workshops over a four-day period. The approximate 200 hundred educators in attendance provided an ideal population for teacher PD satisfaction survey tool implementation. While there are many teacher PD satisfaction survey items and tools available, this work is unique in that it was conducted from the vantage point of science education researchers and educators. This study provides NIGMS SEPA teacher PD focused principal investigators and other educational researchers with similar interest in a validated teacher satisfaction survey tool to utilize across teacher PD programs.

Chapter Four, *In-service teacher perceptions of a food and nutrition professional development workshop* is the third and final essay in this collection. This chapter discusses the secondary data analysis of a Food, Math, and Science Teaching Enhancement Resource (FoodMASTER) teacher PD workshop to determine teacher participants' professional opinions about the quality of the programming. The secondary data analysis examined the observations, focus groups, and evaluation survey to evaluate the teacher PD experience and determine quality component of the teacher PD offering.

Chapter Five, *Summary and implications for policy, practice, and future research* provides important information and resources for STEM teacher PD developers for engaging UM youth in K-12 STEM to better support the STEM career pipeline. These studies made evident that both UM K-12 students and teachers prefer engaging instructional methods; however, some teachers entertain misconceptions about UM K-12 student abilities to be successful in STEM which contributes to the already racial and ethnic imbalance in STEM careers. By creating application-based hands-on teacher PD experiences aimed at preparing teachers to implement similar practices in the classroom considered more engaging by UM K-12 students, STEM PD developers can begin to combat the unbalanced STEM workforce.

The three essays combined in this dissertation enlighten researchers regarding effective teacher professional development methods which will ultimately help K-12 students better understand and engage in mathematics and science concepts. Creating satisfactory professional development opportunities aimed at assisting teachers and educators in meeting complex goals of human growth and development could prove useful in aiding in childhood obesity problems while also improving science and mathematics engagement and interest in science careers. Formal and informal K-12 learning environments provide a unique opportunity to enrich the lives of teachers and educators and the children and families they serve.

Definition of Terms and Acronyms

To understand and clarify the terms used in this study, the following have been defined below.

Food, Math, and Science Teaching Enhancement Resource (**FoodMASTER)**. A compilation of programs aimed at using food as a tool to teach mathematics and science (www.foodmaster.org)

FoodMASTER (FM). Acronym used to describe the program.

FoodMASTER Director (FMD). Acronym used to describe the program director.

Kindergarten to twelfth grade (K-12). Acronym used in the description of the K-12 classroom.

Model Education Networks to Optimize Rural Science (MENTORS). Acronym used to describe a partnering initiative.

National Institute of General Medical Sciences (NIGMS). Acronym used for FoodMASTER funding agency.

Nutrition Science. Defined as the "science of food; the nutrients and substances therein, their action, interaction, and balance in relation to health and disease, and the process by which the organism ingests, digests, absorbs, transports, utilizes, and excretes food substances" (Byrd-Bredbenner et al., 2014).

Partnership. In the context of this collection of essays, a partnership is defined as a relationship between scientists or clinicians and teachers. We are attempting to bridge the gap between research and practice by creating these partnerships to better prepare teachers to utilize hands-on, application-based activities considered engaging to UM K-12 students.

Teacher Professional Development (PD). Acronym used to describe teacher continuing education. PD is a process by which new skills or information is introduced with the intention of improved work performance (Till et al., 2011). Most professional development programs share a common purpose to transform professional practices, beliefs, and understanding of educators (Guskey, 2002). Specifically, a focus on improving participant learning, teacher practices, and student learning must be extant (Loucks-Horsley et al., 2010; Whitworth & Chiu, 2015).

Science Education Partnership Award (SEPA). Acronym used for FoodMASTER funding award.

Science, Technology, Engineering, and Mathematics (STEM). Acronym used to describe a genre of education subjects. These subjects are typically more challenging and less engaging for K-12 students.

STEM education. Defined as "teaching and learning in the fields of science, technology, engineering, and mathematics. It typically includes educational activities across all grade levels— from pre-school to post-doctorate—in both formal (e.g., classrooms) and informal (e.g., afterschool programs) settings" (Gonzalez & Kuenzi, 2012).

Underrepresented minority (UM). Defined as "African Americans, American Indians/Alaska Natives, and Latinos— who have historically comprised a minority of the U.S. population are growing in size and influence" (National Action Committee for Minorities in Engineering, n.d.).

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CHAPTER TWO: Exploring the Role of In-service Teacher Professional Development on Encouraging Underrepresented K-12 Students to Pursue Careers in STEM fields: An Integrative Literature Review

Abstract

This integrative literature review explores teacher professional development practices and concepts which promote careers in Science, Technology, Engineering, and Mathematics (STEM) and health sciences for underrepresented minority (UM) youth. Whittemore and Knafl's (2005) methodology strategies for conducting an integrative review was utilized due to its alignment with health professions. Studies which contained teacher professional development (or teacher characteristics), science and health careers, and underrepresented minorities were included in the review. Of the initial 340 articles identified, 32 underwent full article review, and a final sample of nine articles were deemed appropriate. The final nine articles were summarized and organized based on the pertinence of the findings. Findings from this essay suggest creating and preparing K-12 teachers to implement hands-on application-based STEM activities could provide UM youth with the encouragement and resources needed to pursue the many career opportunities in health and biomedical sciences which are in demand of a more diverse workforce.

Keywords: K-12 student, K-12 teacher, STEM, STEM career, healthcare career, biomedical science, underrepresented minority, in-service teacher professional development

Introduction

Underrepresented minority (UM) groups including Blacks or African Americans, Hispanics or Latinos, and American Indians or Alaska Natives are underrepresented in science, technology, engineering and mathematics (STEM) careers creating a topic of concern for researchers (National Science Foundation [NSF], 2019). According to the U.S. Department of

Commerce (2017) employment in STEM professions increased by approximately 14 percent more than non-STEM professions (24.4 percent versus 4.0 percent, respectively). In fact, STEM professions are expected to grow by almost nine percent from 2014 to 2024 as compared to the approximate six percent growth for non-STEM professions; however, minority groups account for only about 17 percent of the STEM workforce. Almost 70 percent of all scientists and engineers are White with Asians accounting for 13.5 percent, Blacks or African Americans at 7.7 percent, Hispanics or Latinos at 8.6 % percent and American Indians or Alaska Natives 0.3 percent (NSF, 2019). When compared to the U.S. population the numbers are very different with White (not Hispanic or Latino) accounting for 60.4 percent, Asians 5.9 percent, Blacks or African Americans 13.4 percent, Hispanics or Latinos 18.3 percent, American Indians or Alaska Natives 1.3 percent (United States Census Bureau, 2018).

Minority representation in health professions, a STEM-based conglomerate of professions, is another area of interest for science and mathematics educators. The U.S. Bureau of Labor Statistics (2015) reported a significant lack of diversity among healthcare professions. White healthcare professionals dominate the fields with these individuals accounting for 70.3 percent of pharmacists, 71.4 percent of physicians and surgeons, 87.4 percent of speech-language pathologists, and 78.3 percent of nurses. These numbers raise significant concerns regarding STEM career equity considering minority groups currently represent almost 30 percent of the U.S. population (Beede et al., 2011; NSF, 2019) and is projected to increase to 50 percent by 2050 (U.S. Bureau of Labor Statistics, 2016).

The lack of representation in STEM careers from minority groups could be caused by a large gap which exists between minority K-12 student educational attainment as compared to their peers, especially in STEM fields (Kao & Thompson, 2003; Johnston, & Viadero, 2000).

According to the National Center for Education Statistics (2016), the federally required 150 percent, or six-year graduation rates for first-time, full-time undergraduate students attending a four-year public institution in the U.S. were 57 percent for White students as compared to 39 percent for Blacks or African Americans. Researchers and educators should concern themselves with finding effective methods for engaging K-12 students in science and mathematics concepts throughout the lifespan to prevent this gap from growing larger in the years to come. One way to thwart this trend from continuing is to adequately prepare teachers to engage K-12 students in these topic areas through effective professional development (PD) experiences.

This integrative literature review explores teacher characteristics and PD curricular quality concepts which promote careers in science for UM youth. The study will utilize Whittemore and Knafl's (2005) methodology strategies for conducting an integrative review and address the following research questions:

1. What learning experiences have been used to engage UM K-12 students in STEM subjects?
    a. How were these experiences offered?
    b. What types of activities were used?
2. What grades have been targeted to engage UM K-12 students in STEM?
3. What do UM K-12 students need from teachers to promote the pursuit of STEM-based health science careers?
4. What techniques and strategies have been utilized in teacher PD to assist teachers in promoting careers in science for UM K-12 students?

This integrative review of literature provides scientists who offer teacher PD with insight into what teacher PD strategies could assist teachers in helping UM youth pursue careers in science and health professions.

Literature Review

The combination of the Affordable Care Act (ACA) and the growing Medicare-eligible population have resulted in an increase in the need for healthcare professionals, especially physicians, in the U.S. The Association of American Medical Colleges (AAMC) has projected a shortage of more than 90,000 physicians by the year 2020. Considering half the American population by 2050 will be a member of what is currently referred to as minority, it is essential to determine efficient methods for recruiting and retaining underrepresented minority groups to healthcare professions (National Hispanic Health Foundation, 2013). With the declining engagement and interest in STEM pedagogy as early as elementary school, researchers need to find innovative methods for engaging K-12 students, especially underrepresented minority K-12 students, in science and mathematics before high school (Christidou, 2011; Barmby, Kind, & Jones, 2008).

Influencing Science Career Pursuits

As K-12 students matriculate from primary to secondary education, research has shown a rapid decline in interest in STEM subjects such as science and mathematics, which has led to a decreased interest in pursuing STEM careers. K-12 student interest in and attitudes toward science vary greatly between age and gender as well as socio-economic status and cultural background (Christidou, 2011). Minority girls are among the least likely to engage in science and science-based activities (Calabrese-Barton, Tan & Rivet, 2008) with chemistry and physics being the least appealing and engaging (Christidou, 2011). These subject areas are essential for pursuit of healthcare and science careers, but with a lack of engagement at earlier ages, K-12 students are less likely to pursue careers requiring these challenging subjects (Povtin & Hasni, 2014).

K-12 students often do not see the value in learning science and mathematics concepts. Many deem schoolwork as irrelevant to their lives resulting in a lack of engagement and true understanding (Newmann, Wehlage & Lemborn, 1992). K-12 students exhibiting a greater understanding of applicability are more likely to portray more interest and engagement leading to increased performance and persistence (Hulleman & Harackiewicz, 2009). Engaging K-12 students in experiences including integration and career relevancy that are hands-on and application-based could increase interest and persistence in science and STEM careers.

Addressing underrepresented minorities in STEM professions. Underrepresentation of minorities in STEM fields is not a new concern, rather one that has been ongoing since the 1980's with increasing alarm over the past ten years (Oakes, 1990). Considering minority groups only account for 17 percent of the STEM workforce today (NSF, 2019), determining how to increase this number is critical in diversifying STEM. Helping minority K-12 students overcome the barriers to learning experienced in the K-12 education system could be the solution to this problem, making teachers the ideal target population. Assessing teacher quality and experiences provided to K-12 students in the classroom could be the first step in this process (Oakes, 1990).

While all STEM teachers should utilize engaging experiences for K-12 students, research has shown providing K-12 students with application-based experiences which can be applied to everyday life can be the most influential factor on career trajectories (Fleischer, Wemhoff, Obrien, Ural, & Alaways, 2010). This creates meaning and value to learning rather than learning for the only purpose of learning required content (Hulleman & Harackiewicz, 2009).

Underrepresented minorities in health science professions. For the past 25 years the Council on Graduate Medical Education made ensuring that racial and ethnic composition of the general population would be reflected in physicians a goal; however, this is currently not the case. Research has shown minority physicians are more likely to serve minority populations making it essential to engage minority K-12 students in science and mathematics (Milem, 2003; Williams & Rucker, 2000; Institute of Medicine, 2002). For example, African American physicians account for a small percentage of the physician population, approximately three to five percent, but they serve around 30 percent of the total African American patients leaving the remaining 70 percent to be served by White physicians (or physicians of other races?). Dentists, psychiatrists, and other healthcare professionals represent a similar trend in professional practice (Komaromy, 1996; Milem, 2003).

A more diverse population of health professionals will ultimately increase cultural competency, provide greater access for minority patients, and increase health care administrator knowledge about diverse populations resulting in better responsiveness to their needs (Beach et al., 2005). A more diverse healthcare profession will also improve research agendas as well as minority patient treatment protocols as a result of the increase in minority-based health research (Milem, 2003; Saporu, 2015). Fifteen to 20 percent of the population in the U.S. is living in an area where healthcare is inadequate. The physician to patient ratio in these rural areas is only 39.8 to 100,000 compared to 53.3 to 100,000 in urban areas (Hing & Hsiao, 2012). Bearing in mind in many areas across the U.S., most of the individuals living in rural areas are considered to be a member of a minority group with most White families living in suburban areas, there is not only a need for more healthcare providers in general, but also a greater need for underrepresented minority practitioners (Komaromy, 1996; Milem, 2003; Saporu, 2015).

Underrepresented minorities in biomedical science. Biomedical sciences are another area of STEM education and career concern for the U.S. population. Not only does interest in biomedical sciences often lead to careers in health professions, but there is also a need to meet the demands of the biomedical workforce. It is estimated that by the year 2026, there will be a 13 percent increase in demand for biomedical scientists (US Bureau of Labor Statistics, 2016). Failure to meet this demand from our growing minority, soon to be majority, will continue to present problems for the U.S. scientific workforce labor needs. Biomedical and health professions are becoming less interesting to many high school and undergraduate students, resulting in critical shortages in these professions. With demographic trends indicating 50 percent of the population will be minority by 2050, it is essential for biomedical professions to increase their efforts to recruit and retain minority groups (Smedley, Colburn, & Evans, 2001).

There is also a recognized need to increase the number of research-based healthcare professionals, especially physicians. Physicians with a strong foundation in research can strengthen translational research and improve patient outcomes by helping other physicians and healthcare professionals better understand and apply research to practice. Disease cannot be effectively treated without appropriate application of research to practice (Daye, Patel, Ahn & Nguyen, 2015). Considering the already low number of minority physicians, there is even more demand for minority physician scientists. An increase in the number of minority physician scientists will greatly reduce health disparities considering minorities are typically less healthy, have greater difficulty accessing health care, and often experience lower quality of health care at the doctor's office (Smedley et al., 2001).

Fortunately, the National Institutes of Health (NIH) has recognized this decline and increased grant support for strengthening the physician scientist workforce (Daye et al., 2015).

They have also introduced programs aimed at increasing the number of minorities pursuing biomedical sciences careers; however, many of the programs focus on the graduate level resulting in a loss of reaching a larger population. At this point, there is a lack of candidates because our current systems fail to support pipeline programs from K-12 to undergraduate education. Igniting K-12 student interest in STEM before attending a post-secondary institution can increase the number of individuals pursuing STEM degrees and careers (Perry, Link, Boelter, Leukefeld, 2012). To ensure this occurs, teachers should engage in targeted STEM professional development experiences (Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010).

Teacher Professional Development Quality

Professional development has been defined as a process by which new skills or information is introduced with the expectation of improved work performance (Till, Ferkins, & Handcock, 2011). Most professional development programs share a common purpose: to transform professional practices, beliefs, and understanding of educators (Guskey, 2002). Specifically, a focus on improving participant learning, teacher practices, and K-12 student learning must be extant (Loucks-Horsley et al., 2010; Whitworth & Chiu, 2015). Considering teacher quality is directly related to the quality of teacher PD experiences, exploring what is considered quality PD is essential for PD developers (Guskey, 2000).

Effective teacher professional development should ensure there is focus on content, active learning, coherence, duration, and collective participation. Addressing each of these components helps to ensure teachers experience an increase in knowledge and skills, which leads to improved practice and improved K-12 student achievement (Desimone, 2009). Of the five elements suggested by Desimone (2009), duration has been identified as particularly crucial and most often not properly employed. While an exact amount of time needed has not been identified, research suggests effective teacher PD experiences should be spread out over time (Blank, 2013). This allows for a more intensive teacher PD by providing more detail and continued support; however, many PD programs are only offered in one sitting resulting in less effective teacher PD programs due to limited exposure and reinforcement (Opfer & Pedder, 2011).

The purpose of this integrative literature review was to explore teacher characteristics and PD curricular quality concepts due to the demand for a more diverse health and biomedical workforce since limited research is available exploring effective methods for igniting interest in STEM careers prior to post-secondary education as evidenced by the limited research identified in this review. This is turn will promote careers in science for UM youth and provide scientists who offer PD the insight into which teacher PD strategies could be of assistance to teachers. As a result, UM youth will be encouraged to pursue careers in science and health professions.

Methodology

This integrative review of literature was conducted during April 2019 to explore teacher professional development in the context of engaging minority K-12 students in science and mathematics content. Engaging K-12 students in mathematics and science prior to entering postsecondary education can lead to an increased interest and pursuit of science and health-related careers. Whittemore and Knafl’s (2005) framework for conducting integrative literature reviews was selected as a guide. The selected methodology as outlined by Whittemore and Knafl (2005) involved problem identification, literature search, data evaluation, data analysis and presentation of the literature. This health science-based framework for conducting an integrative literature review was selected due to the author’s background in nutrition and the goal of determining what UM K-12 students need from teachers to pursue STEM-based health science professions. The framework of this review investigated theoretical literature and non-experimental studies related to understanding how K-12 teachers are being prepared to engage UM students in STEM subjects required to pursue health science professions. The inclusion of several types of literature such as theories, concepts, and relevant issues within K-12 education and health sciences is the primary advantage of using this methodology to understand how K-12 teachers are being prepared to engage UM students in STEM subjects. Methods employed allowed for a comprehensive search with purposeful sampling of the current body of literature to ensure all relevant sources were identified within K-12 education and STEM-based health sciences disciplines.

Studies included in this review were from January 1999 to May 2019 which provides a comprehensive overview of previous efforts, and illustrates what is considered effective practice today. Both qualitative and quantitative studies are included in the search. A total of five data bases were searched: Academic Search Complete, ERIC via ProQuest, Science Direct, PsycINFO, PubMed, and CINAHL. Search terms used included *teacher (educator) professional development (training) science, mathematics, underrepresented minority (minorities, minority) and health career* (health sciences career*, health profession*).*

Inclusion and Exclusion Criteria

Studies which included teacher professional development (or teacher characteristics), science and health careers, and underrepresented minorities were included in the review. To meet inclusion criteria, publications needed to be (a) published in English, (b) published in a peer-reviewed journal, (c) published after 1999 to provide the most current research, (d) include K-12 students or teachers, (e) discuss minority students, (f) discuss health careers or pedagogy (including the context of mathematics or science), (g) include professional development (or teacher characteristics) of in-service K-12 teachers, and (h) conducted in the U.S. Other countries were not included in this review due to major differences in education systems between the U.S. and many other countries.

Data Abstraction and Synthesis

The initial database searches revealed a total of 340 studies for review. All studies were then imported to Covidence, an online systematic review software service for improving evidence synthesis. After duplicates were removed (n=4), 336 titles and abstracts were reviewed based on the inclusion criteria. Articles not classified as research articles such as reports or conference presentations (n=15), along with those not considered empirical research (n=1) were not included. Also excluded were studies in which the full text was not accessible (n=2), those conducted outside on the U.S. (n=56), those that did not discuss students or teachers in the K-12 setting (n=86), or did not discuss STEM disciplines (n=115), and those that focused on pre-service teachers (n=29). A total of 304 articles were excluded during title and abstract review.

Once title and abstract review were conducted, 32 full-text studies were reviewed for extraction. Studies were excluded if they did not discuss underrepresented minority students (n=5), did not discuss effective teacher professional development or characteristics (n=15), or were exclusive to differences in gender only (n=3). The final sample included 9 studies, which were read multiple times and analyzed. See (Figure 2.1) for the flowchart of article extraction process.

Articles were summarized and organized based on the pertinence of the findings. Information collected for data synthesis includes methodological design, sample, and findings. Once organized, findings will be analyzed again to identify any recurring phenomena (Barnett-Page & Thomas, 2009).

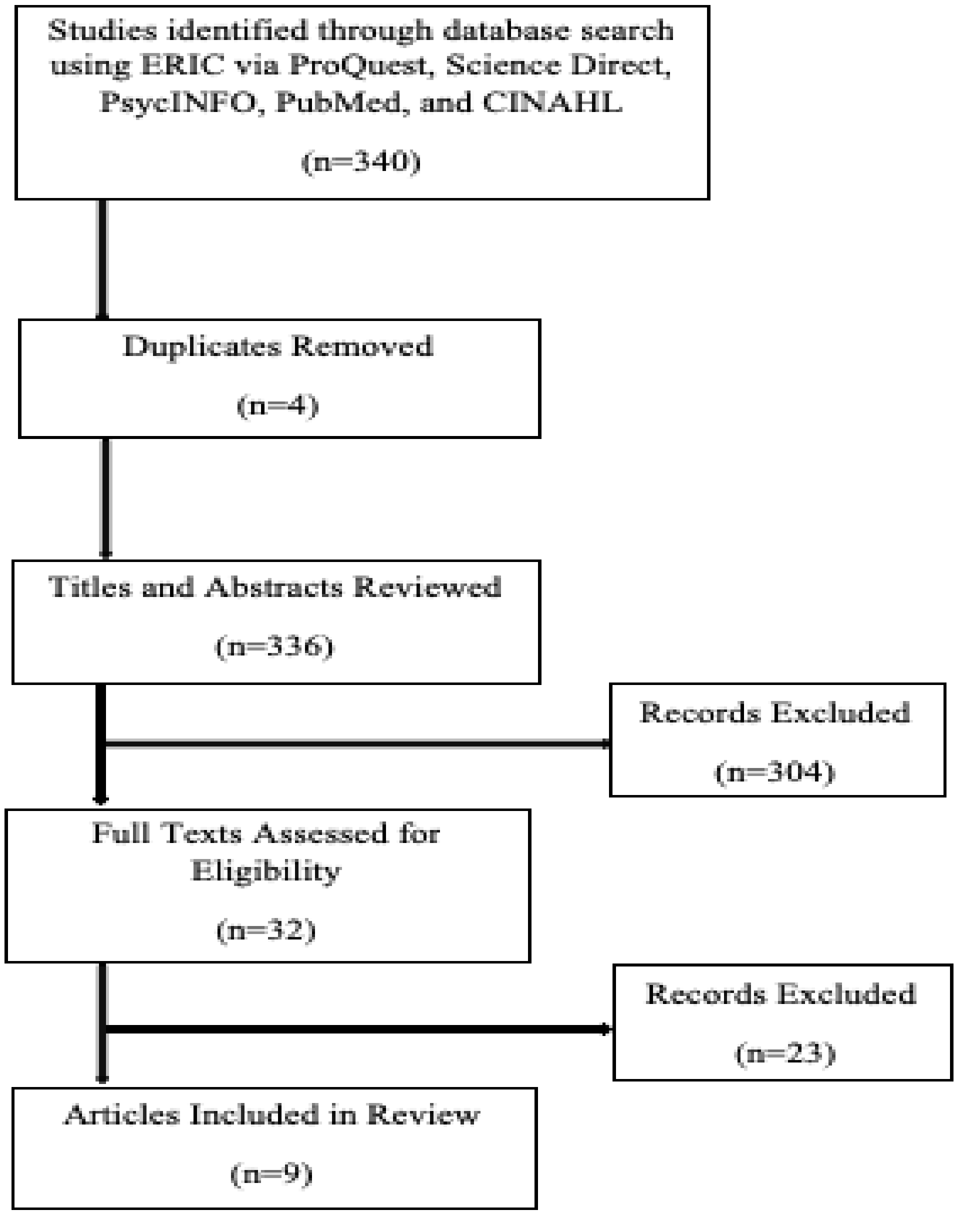

Figure 2.1 Article extraction flowchart

Results

This integrative literature review presents peer reviewed scholarly literature focused on STEM interventions aimed at engaging underrepresented minority K-12 students. Four primary research questions were addressed:

1. What learning experiences have been used to engage UM K-12 students in STEM subjects?
    a. How were these experiences offered?
    b. What types of activities were used?
2. What grades have been targeted to engage UM K-12 students in STEM?
3. What do UM K-12 students need from teachers to promote the pursuit of STEM-based health science careers?
4. What techniques and strategies have been utilized in teacher PD to assist teachers in promoting careers in science for UM K-12 students?

Although many of the studies outlined in this review directly discuss teacher PD, most focused primarily on K-12 student experiences or perceptions. Understanding what K-12 students need from teachers and learning experiences could provide researchers with necessary information to better inform teacher PD program development.

Program Descriptions

An overview of each article can be found in Table 2.1 with study descriptions including STEM focus, study type, program type, age group, target population, and sample size provided in Table 2.2. Three studies were not specific to a STEM field, rather were aimed at STEM in general while the remaining six had a specific focus. Three studies focused on engineering, one on biomedical science, one on computer science, and one on science utility. Age groups addressed in each study were primarily high school (n=6) or middle school students (n=5) with one study including elementary students. Target populations were comprised of K-12 students, teachers, principals, and school counselors. Of the nine studies, seven included K-12 students, eight included teachers, one included principals, and one included school counselors in their samples.

Table 2.1
Article Descriptions

Author / Year	**Title**	**Description**
Boyce, e al. (2019)	Implementation and evaluation of a biotechnology research experience for African-American high school students.	Explored lessons learned and shared best practices from the implementation and evaluation of a high school STEM program aimed at providing an authentic research experience for African American K-12 students.
Chiu et al. (2013)	WISEngineering: Supporting precollege engineering design and mathematical understanding	Explored the development and pilot testing of WISEngineering, a web-based engineering design learning environment.
Hayden et al. (2011)	Increasing K-12 student interest and attitudes in STEM: Professional development and activities to engage and inspire learners.	iQUEST was created to promote K-12 student interest and attitudes toward careers STEM. The project included a K-12 student summer camp program, and professional development model which have led to successful increases in K-12 student performance.
Li et al. (2015)	Supporting K-12 students with disabilities and limited English proficiency: STEM educator professional development participation and perceived utility.	Explored K-12 STEM educator participation and perceived utility about professional development specific to the needs of K-12 students with categorical disabilities and limited English proficiency (LEP).
Munson et al. (2011)	Computing at the high school level: Changing what teachers and K-12 students know and believe.	Examined a summer program aimed at improving high school students, teachers and guidance counselors understanding of the opportunities available in computer fields.
Nathan et al. (2011)	How professional development in Project Lead the Way changes high school STEM teachers' beliefs about engineering education.	Examined the impact of Project Lead the Way (PLTW) instruction and professional development training on the views and expectations regarding engineering learning, instruction and career success of pre college engineering teachers.
Scott (2012)	An investigation of science, technology, engineering and mathematics (STEM) focused high schools in the U.S.	Explored the characteristics of ten science, technology, engineering and mathematics (STEM) focused high schools in the U.S.
Schmidt et al. (2019)	Why are we learning this? Using mixed methods to understands teachers' relevance statements and how they shape middle school students' perceptions of science utility.	Examined how middle school science teachers perceived and communicated the relevance of science content in their classrooms.
Ziaeefard et al. (2017)	Co-robotics hands-on activities: A gateway to engineering design and STEM learning.	Explored learning contexts and hands-on activities of a summer camp using robots which work with people (co-robots) in broadening and sustaining pre-college student engagement in Science, Technology, Engineering, and Mathematics (STEM).

Table 2.2
Program Descriptions[1]

						Sample Size	
Program	**STEM Subject**	**Study Type**	**Program Type**	**Age Group**	**Target Population**	**K-12 students**	**Teachers**
Project ENGAGES	BM	PL	SC, PD	HS	S, T	45	3
WISEngineering	E	PL	SY,	MS	S, T	26	2
iQuest	All	QE	PD, SC	MS	S, T	44	0
SASS – PD for LEP & STEM	All	RC	NP	ES, MS HS	T	0	3,385,170
SPIRIT	CSc	QE	PD, SC	HS	S, T, C	68	T=24 C=11
Project Lead the Way	E	QE	PD	HS	T	0	182
STEM HS	All	CCS	NP	HS	S, T, P		10 schools (1 T or P per school)
Science utility	Sc	CMM	NP	MS	T, S	306	4
Co-robotics	E	PL	SC	MS, HS	S	MS=51 HS=76	0

[1]BM, biomedical sciences; C, counselor; CCS, controlled case study; CMM, convergent mixed methods; CSc, computer science; E, engineering; ES, elementary school (grades K-5); HS, high school (grades 9-12); MS, middle school (grades 6-8); NP, no program; P, principals; PD, professional development; PL, pilot; QE, quasiexperimental; RC, randomized control; S, students; SC, summer camp; SY, school year; T, teachers

Evaluation methods. Of the nine studies extracted, seven employed mixed methods for evaluation, seven discussed specific teacher professional development methods, and eight identified characteristics of effective learning experiences for minority K-12 students. Evaluation methods ranged from specific validated surveys to classroom observations. Most studies employed mixed methods (n=7) collecting data from interviews, observations, focus groups, documents, and surveys. The remaining two studies utilized only quantitative survey data for analysis. Evaluation methods for individual studies can be found in Table 2.3.

Table 2.3
Evaluation Methods Used in Articles[2]

Program	Qualitative	Quantitative
Project ENGAGES	I, O, FG, DA	S, PP(K, SG)
WISEngineering	I, O	PP(K), STS
iQuest	I, O	PP(TOSRA, ICTA)
SASS – PD for LEP & STEM	None	SASS
SPIRIT	EE, FG	PP(A, K)
Project Lead the Way	None	P(EEBEI-T)
STEM HS	I, E	STS
Science utility	I, O	PP(PSU), EOCR
Co-robotics	I, O	PP(E, K)

[2] A, attitudes; DA, document analysis; EE, exit evaluation; EEEBEI-T, engineering education beliefs and expectations instrument for teachers; EM, email; EOCR, end of class report; FG, focus groups; I, interview; ICTA, information and communication technology attitude; K, knowledge; O, observations; P, post; PP, pre-post; PSU, perceived science utility; S, satisfaction; SASS, a system of related questionnaires; STS, standardized tests; TOSRA, test of science related attitudes

K-12 student Learning Experiences

Table 2.4 provides an overview of the K-12 student learning experiences discussed by each study. Eight of the nine studies provided descriptions of minority student K-12 learning experiences. The remaining ninth study (Li et al., 2015) did not discuss a specific program or curriculum. Rather, it conducted a secondary data analysis of the Schools and Staffing Survey (SASS). SASS collects survey data from school staff on the context of elementary and secondary education.

Characteristics of learning experiences including career content, hands-on, application-based, and integration were illustrated in the remaining eight studies. Of the eight studies discussing learning experiences of students, five studies included all four components. Three included everything except a career content component. Four were summer camp experiences with one also including activities teachers can implement throughout the school year (not equating to an entire curriculum). Three of the summer camp experiences lasted one week with the remaining summer camp experience lasting four weeks. While summer camps can immerse minority K-12 students in STEM for a week or two each year, teachers spend approximately seven hours a day, 180 days a year with K-12 students. This means teachers spend 1,260 hours each year with K-12 students. When compared to a two-week summer camp with approximately eight hours a day for 10 days (80 hours), teachers spend much more time with K-12 students. Thus, making them the ideal target population for increasing STEM engagement.

Table 2.4

K-12 Student Learning Experience Characteristics[4]

Program	**Length**	**Career Content**	**Hands-on**	**Application-based**	**Integrative**
Project ENGAGES	4 week SC, 4 week RA	Y	Y	Y	Y
WISEngineering	SY	Y	Y	Y	Y
iQuest	1 week SC, SY	N	Y	Y	Y
SASS – PD for LEP & STEM	-	-	-	-	-
SPIRIT	1 week SC	Y	Y	Y	Y
Project Lead the Way	SY	Y	Y	Y	Y
STEM HS	SY	Y	Y	Y	Y
Science utility	SY	N	Y	Y	Y
Co-robotics	1 week SC	N	Y	Y	Y

[4]RA, research experience; SC, summer camp; SY, school year

Five of the eight articles were aimed at providing curricula or activities for teachers to implement throughout the school year. One of these provided a description of STEM high schools. Attending a STEM high school was found to increase student interest and persistence in STEM (Hilton & Lee, 1998). Students attending these schools perform better than their peers on standardized tests and are more likely to pursue STEM fields. Courses and methods offered by STEM schools vary greatly from traditional schools. Students are provided with more core time in STEM, STEM-focused electives, work-related experiences, and mentorship through a capstone project which reflects the learning goals of the school (Scott, 2012). While many STEM schools serve underrepresented minority youth, additional programs are also necessary to engage K-12 students in STEM. Engaging K-12 students in hands-on application-based programs is considered essential to K-12 student interest, achievement, and persistence (Schmidt, Kafkas, Maier, Shumow, & Kacker-Cam, 2019; Boyce et al. 2019).

Inspiring interest in STEM careers. One aspect many learning experiences lack is access to career application. K-12 students do not place value in learning unless they are able to see the connection between what is being taught and real life (Hulleman & Harackiewicz, 2009; Fleischer et al., 2010). Connecting K-12 students through a summer bridge program which employs mentorship from science professionals could be one method for engaging K-12 students and promoting persistence (Boyce et al., 2019); however, at this point, many K-12 students have already lost interest in STEM.

Programs aimed at engaging underrepresented minority youth can lead to persistence in STEM careers by providing K-12 students with the opportunity to engage in STEM through real world experiences. Using activities based on concepts K-12 students have a preexisting contextual knowledge of can improve engagement and comprehension (Carraway-Stage, Hovland, Ochab, Diaz, & Duffrin, 2014; Hovland et al., 2013; Roseno, Carraway-Stage, Hoerdemann, Diaz, Geist, & Duffrin, 2015). K-12 students can apply concepts to daily activities rather than only calculating a math problem because their teacher assigned the problem. Engaging K-12 students with thought, creativity, and collaboration can not only improve academic achievement, but also lead to improvements in tolerance and pro-social skills among at-risk minority youth (Chiu et al., 2013).

K-12 student interest and engagement in activities can also be dependent upon perception of difficulty, prior experience, and confidence (Ziaeefard, Miller, Rastgaar & Mahmoudian, 2017). Teachers, especially, play a crucial role in impacting K-12 student perceptions and confidence. Even simple relevancy statements can help K-12 students understand the usefulness of the content being taught; however, this simple tool is not being utilized often enough in schools (Schmidt et al., 2018). Teachers may not know how to make the connection between content and real life, have a strong grasp on the content, or even believe their students lack the ability to be successful in STEM and would not be able to move forward in science (Schmidt et al., 2019). Considering minority youth are less commonly encouraged to pursue STEM careers, teacher perceptions regarding their ability to succeed in science could be part of the problem (Pizzolato, 2006). Unfortunately, some teachers have expressed beliefs about who science is “for” and “not for”, which may indicate socioeconomic status plays a role in teacher perceptions of student ability to perform in science (Schmidt et al., 2019). Not knowingly, other teachers have indicated socioeconomic status and culture play a role in K-12 student pursuit of engineering. Academic achievement, social network, and family history have identified by teachers as preconditions for K-12 students pursuing engineering as a career, which places great value on the impact of socioeconomic status and culture (Nathan, Atwood, Prevost, Phelps & Tran, 2011).

Teacher PD Characteristics

Table 2.5 outlines teacher PD characteristics included in each study. Three of the nine studies did not directly discuss teacher PD experiences or methods. The first of the three articles, PD for LEP and STEM teachers, analyzed responses from teachers using the Schools and Staffing Survey (SASS) database to determine teacher engagement in PD directed at reaching K-

12 students with disabilities including Limited English Proficient (LEP) students. SASS collected survey data from school staff on the context of elementary and secondary education (Li et al., 2015). The science utility study collected data in the form of classroom observations, teacher interviews, and K-12 student science utility surveys to determine the effectiveness of science teachers to incorporate the purpose of content taught in the classroom and the K-12 student's perceived utility of science. Co-robotics briefly discussed implementing a teacher PD workshop in the future which would prepare teachers to engage K-12 students using the Co-robotics programming throughout the school year.

The remaining six studies provided detailed information about the teacher PD experiences. All teacher PD experiences were primarily in-person workshops lasting from two days to ongoing PD over two years. Of the seven PD experiences discussed, only six provided detailed information regarding how the PD was implemented. Content focus was clear among all the PD experiences discussed with active learning occurring in five, coherence in four, and collective participation in three. Four of the studies included unique characteristics including feedback after teachers implemented the information learned, student selection for camp experiences, science professional mentors, teacher mentors, coaches, online collaboration network, team teaching, and converting existing teacher lesson plans to meet the program requirements.

Table 2.5
Teacher PD Characteristics[4]

Program	Length	Delivery Method	Method Components	Unique Characteristics
Project ENGAGES	6 weeks	IP	CF, AL, C	feedback, student selection
WISEngineering	2 days	IP	CF	None
iQuest	2 years (initial 3-day workshop)	IP, ON	CF, AL, C, CP	science professional mentors, online collaborative network, team teaching
SASS – PD for LEP & STEM	-	-	-	-
SPIRIT	2 weeks	IP	CF, AL, C, CP	converted existing teacher lesson plans
Project Lead the Way	2 weeks	IP, ON	CF, AL	None
STEM HS	Varied	IP	CF, AL, C, CP	science professional mentors, teacher mentors, master teachers, coaches
Science utility	-	-	-	-
Co-robotics	TBA	IP	TBA	TBA

[4]AL, active learning; C, coherence; CF, content focus; CP, collective participation; IP, in-person; ON, online; TBA, to be announced

Instructional methods utilized by teachers can be one of the most impactful factors for engaging K-12 students. Employing application-based, hands-on activities has been found to better engage minority K-12 students in the learning process (Schmidt et al., 2019; Boyce et al. 2019; Hulleman & Harackiewicz, 2009). Whether these activities occur during a summer camp experience or throughout the school year, teachers play a pivotal role in K-12 student success. Teachers need to be adequately prepared to engage K-12 students based on their needs (Loucks-Horsley et al., 2010). Considering the impact teachers have on K-12 students, it is important to understand what teachers need from PD experiences to better engage K-12 students in STEM content. STEM high schools not only offer engaging application-based instruction for K-12 students, but they also provide teachers with quality teacher professional development experiences which are ongoing and employ multiple unique methods. Collaboration was a key component in many STEM school teacher PD models. Numerous schools provided master teachers, team teaching, and coaching to teachers throughout the school year (Scott, 2012). Collective participation via collaboration is a critical feature for effective teacher PD (Desimone, 2009). In fact, of the five components of effective teacher PD identified by Desimone (2009), STEM high schools employed all five components, even duration. STEM schools employ ongoing professional development activities from initial experiences spanning a few days scheduling time throughout the year to engage in various PD opportunities (Scott, 2012).

Teacher PD experiences are typically shorter in length with less impact on teacher efficacy and attitudes (Munson, Moskal, Harriger, Lauriski-Karriker, & Heersink, 2011); however, by adding and online collaborative component PD developers could meet the duration minimum. Building an online collaborative network where teachers can utilize chats, wikis, blogs, forums, and journals to discuss teaching experiences after the professional development workshop can lead to improved fidelity (Hayden, Ouyang, Scinski, Olszewski & Bielefeldt, 2011). By supporting professional dialog throughout the school year, online networks can also lead to improved teacher efficacy (Prensky, 2001).

To improve teacher efficacy, teacher PD experiences should also include active learning experiences (Desimone, 2009). Engaging teachers through application-based and career motivated activities can provide valuable active learning experiences (Nathan et al., 2011; Scott, 2012; Hayden et al., 2011). Teachers can experience what students will be learning and in some instances partner with a science professional to better understand the career opportunities (Nathan et al., 2011; Hayden et al., 2011). Participating in targeted professional development experiences can provide teachers with the knowledge and skills needed to reach this goal. While most PD programs include the suggested elements outlined by Desimone (2009), other aspects such as online collaboration, partnership with career professional mentors, collaboration with other school professionals, ongoing support, and team teaching were also been mentioned as effective components of teacher PD (Nathan et al., 2011; Scott, 2012; Hayden et al., 2011).

Discussion and Implications

This integrative literature review highlighted how the K-12 education system engages minority K-12 students in learning STEM and pursuing its career opportunities. Whether it is medicine, biomedical science, or many of the other STEM professional opportunities, there is a concern for the alarmingly low number of minorities in these professions. It is well recognized that biomedical science programs can provide undergraduate students with a research base which will support and encourage the pipeline from undergraduate studies toward health professions, academic medicine, and biomedical research (Gunn, Ledford, Mousetes, Grever, 2018); however, focusing on students pursuing post-secondary education excludes a large number of potential future STEM professionals. Considering the 18 percent gap between UM groups and their peers' six-year graduation rates for first-time, full-time undergraduate students attending a four-year public institution in the U.S., focusing on students already enrolled in higher education is not going to significantly impact workforce demographics (Kao & Thompson, 2003; Johnston, & Viadero, 2000; National Center for Education Statistics, 2016). The solution, therefore, could be to direct K-12 interest towards the available pipeline STEM programs.

Age, gender, socio-economic status, and cultural background greatly impact K-12 student interest in, and attitudes toward science (Christidou, 2011). For example, minority girls are the least likely group to engage in science and science-based activities (Calabrese-Barton et al.2008). By promoting STEM to K-12 students before graduating from high school, the number of minority K-12 students pursuing STEM careers could be greatly increased. Considering middle school has been specifically identified as an ideal time to peak K-12 student interest in STEM, efforts should be made to target this population. Research has shown a significant decline of interest in science and mathematics during middle school years, which has led to diminished interest in the pursuit of STEM careers. In middle school students are making decisions about courses which will impact high school course registration in advanced level science and mathematics courses which can ultimately lead to pursuit of enrollment in STEM-based post-secondary education programs (Valla & Williams, 2012). Creating a fun environment for K-12 students to learn science and mathematics can increase interest and persistence in STEM careers. Teachers, however, must be adequately prepared to engage the ever-changing diverse K-12 student body.

When developing teacher PD experiences the focus should not only be on increasing K-12 student achievement, but also improving teacher learning and practices (Loucks-Horsley et al., 2010; Whitworth & Chiu, 2015). Effective teacher PD should consider content, active learning, coherence, duration, and collective participation essential elements to address. Ensuring each of these five components has been examined and appropriately employed can improve teacher knowledge and skills, which can lead to improved practice and increased K-12 student achievement (Desimone, 2009). Oftentimes teacher PD programs cannot employ all five elements with duration being the limiting factor (Munson et al., 2011). Programs which are shorter in length can combat this primary limitation by including an online collaborative community to support ongoing professional dialog throughout the year (Presnky, 2001; Hayden et al., 2011). Once these basic requirements are met, a focus on target K-12 student populations such as UM youth can be considered.

While there are many programs aimed at engaging minority K-12 students in STEM, very few programs provide training to teachers on how to effectively engage minority K-12 students in STEM. In fact, some teachers subconsciously perceive minority K-12 students as lacking the ability to be successful in STEM resulting in a lack of support and reduced science utility among K-12 students (Schmidt et al., 2019). When asked what characteristics students need to be successful in STEM-based careers, many teachers would describe student attributes aligned with those of a middle-class White student and family (Nathan et al., 2011; Schmidt et al., 2019). These misconceptions need to be addressed to ensure teachers are providing K-12 students with what they need to be successful in STEM (Li, Ernest & Williams, 2015; Nathan et al., 2011; Schmidt et al., 2019).

Implications

Over the next 30 years 50 percent of the U.S. population will be what is now considered minority, which indicates a 10 percent decrease in the Non-Hispanic White population (United States Census Bureau, 2018) resulting in a need to diversify the STEM workforce (NSF, 2019); however, initiatives created to promote STEM engagement from UM groups during the past forty years have not produced the intended improvements (Milem, 2003; Williams & Rucker, 2000; Institute of Medicine, 2002; Daye et al., 2015). Considering many of these programs are aimed at post-secondary education and high school students, more effort should be placed on elementary and middle school students to engage and retain interest in STEM at an earlier age (Povtin & Hasni, 2014; Christidou, 2011; Perry et al., 2012).

K-12 student engagement in learning begins with teachers which demonstrates a need for teachers to be adequately prepared to implement hands-on, application-based methods in the classroom (Perry et al., 2012; Fleischer et al. 2010). Possessing a greater understanding of applicability can increase interest and engagement resulting in increased performance and persistence (Hulleman & Harackiewicz, 2009). Focusing on preparing teachers to better understand the needs of UM youth using curricula based in biomedical science, which is innately hands-on and applicated-based, can serve as a pipeline from the K-12 education system to STEM undergraduate programs (Perry et al., 2012). Creating and preparing teachers to implement these efforts could provide UM youth with the tools needed to pursue the many career opportunities in health and biomedical sciences which demand a more diverse workforce (Li, Ernest & Williams, 2015; Nathan et al., 2011; Schmidt et al., 2019; Perry et al., 2012; Fleischer et al. 2010).

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CHAPTER THREE: Validation of an In-service Teacher Professional Development Satisfaction Survey

Abstract

This essay utilized secondary data analysis to validate a teacher professional development satisfaction survey for scientist and clinician developed STEM educator professional development programs such as those funded by National Institute of General Medical Science (NIGMS), Science Education Partnership Award (SEPA). The survey was developed with NIGMS SEPA teacher PD focused principal investigators' input and contains items which can be utilized across programs. This secondary data analysis assessed information collected from the survey piloted within the NIGMS SEPA funded Model Education Networks to Optimize Rural Science (MENTORS) Annual Summer Institute. The 21-item survey underwent content, face, and construct validity as well as reliability. Of the 21 items, 17 were considered quantitative and analyzed for construct validity and reliability. Of the 17 items, 12 assessed participant level of agreement and five assessed perceived value and quality. Two subscales were identified through factor analysis including participant reactions and motivation. The final survey included 20-items after one item was deleted after undergoing reliability analysis indicating a significant increase in the Cronbach's alpha of the motivation subscale for the perceived value and quality items. Utilizing a valid and reliable PD evaluation survey across STEM programs can provide PD developers with necessary participant perceptions regarding satisfaction and preparedness to implement hands-on application-based STEM activities.

Keywords: K-12 teacher, STEM, in-service teacher professional development, program evaluation, validity, reliability

Introduction

The estimated cost of professional development (PD) in the United States is between one to four billion dollars per year (Wilson, 2013). Given the amount of money, time, and resources being used for PD, it is crucial to gain a better understanding of what produces effective and successful PD programming for K-12 teachers. Evaluating PD experiences can inform improvement for future programming, determine program worth, and justify the existence of the training experience (Kirkpatrick, 1994). By starting with the Kirkpatrick model to evaluate teacher PD, essential information can be provided to program developers which may determine program effectiveness and usefulness. The Kirkpatrick model for evaluating training, or professional development, specifies four primary levels of evaluation: (a) reaction, (b) learning, (c) behavior, (d) results (Kirkpatrick, 1994). Reaction, or participant satisfaction is at the baseline level of this model. See Figure 3.1.

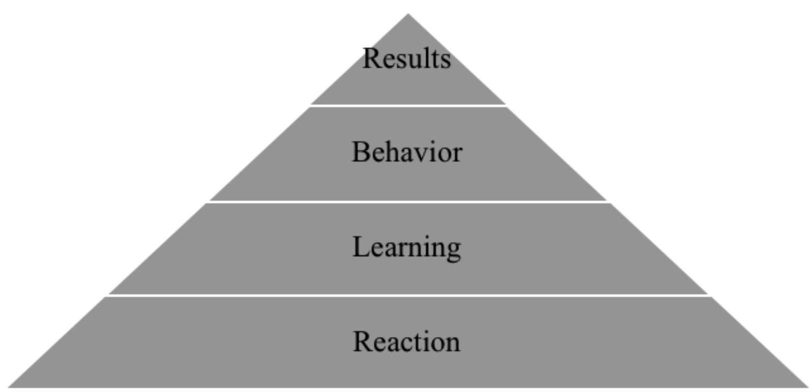

Figure 3.1 Kirkpatrick's four levels of evaluation model

While there are existing validated PD evaluation instruments, there is a gap in the research regarding teachers' thoughts and perceptions of their professional development experience (Till, Ferkins, & Handcock, 2011). Participant reactions are at the base of Kirkpatrick's model, and without satisfying participant needs, the remainder of the elements of evaluation may not be useful. Teachers may gain the intended knowledge or skills, but without an understanding of teacher motivation and satisfaction, dissemination of the intended content may not occur as intended by PD developers (Gorozidis, & Papaionnou, 2014). PD experiences should be focused on the participants and their needs. Without collecting information regarding their satisfaction, PD developers cannot make informed improvements to the delivery of programming (Guskey, 2002; Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010).

This study applied Kirkpatrick's four-level-model (1994) as a foundation to develop survey items which can be utilized across scientist-developed teacher PD programs and the National Institute of General Medical Science (NIGMS), Science Education Partnership Award (SEPA) teacher PD programs. The survey was developed with NIGMS SEPA teacher PD focused principal investigators' input and contained items which can be utilized across programs. This tool was piloted within the NIGMS SEPA funded Model Education Networks to Optimize Rural Science (MENTORS) program. This program offers a teacher institute which invites a wide variety of teacher PD offerings providing an ideal population for teacher PD satisfaction survey tool implementation. Developing a Kirkpatrick-based, level one satisfaction survey can provide PD developers with key information needed to assess the degree by which PD experiences are effective at promoting PD engagement and recruitment (Nasser & Shabti, 2009), which is essential for NIGMS SEPA teacher PD-focused principal investigators. The study employed a secondary data analysis to evaluate the development and implementation of a STEM teacher PD satisfaction tool to answer the following research question:

1. What is the factor structure and reliability of the teacher satisfaction survey?

Literature Review

Professional development has an array of definitions ranging from basic activities intended to improve teacher performance or knowledge, to dynamic communities of continued learning (Desimone, 2009). Teacher satisfaction with the PD experience is an essential evaluation component for designing and improving future PD programming (Nasser & Shabti, 2009). Despite research stating the importance of teacher satisfaction, evaluation of STEM and health science teacher PD experiences has shifted from the needed focus on satisfaction (Frechtling, Sharp, Carey, & Vaden-Kiernan, 1995; Guskey, 2000).

Satisfaction

Three factors may affect teacher satisfaction with PD experiences including (a) teacher background characteristics, (b) program characteristics, and (c) motivation (Nasser & Shabti, 2009). Background characteristics of the teacher such as education level, content expertise, and school expectations dynamics are typically diverse; however, PD programming should be specific in what it aims to provide participants. Program characteristics are unique and should match the needs of its intended teachers through content and implementation. Teachers select a PD experience based on content interest making it essential for PD developers to be clear in their program description (Nasser & Shabti, 2009; Nir & Bogler, 2008). Motivation, however, is essential for a successful work environment and goes beyond that of the program itself.

Motivation is also referred to as beliefs, attitudes, efficacy, knowledge, and perceptions, all of which influence change at the personal level. One of the strongest influences on teachers is their perceived self-efficacy in their ability to facilitate a program that will impact students' learning outcomes favorably (Ingvarson et al., 2005). Teacher thinking and self-efficacy have been identified by The National Commission on Teaching and America's Future as an area of importance when developing teacher PD training experiences (Martin, McCaughtry, Hodges-Kulinna, & Cothran, 2008).

Self-efficacy is considered an essential component to determining teachers' ability to be effective in implementing the PD's intended content after attending the PD experience (Ingvarson et al., 2005). Bandura defines self-efficacy as an individual's belief in his or her ability to complete a specific behavior at a level which will promote achievement of a desired outcome. Self-efficacy is composed of two components, efficacy expectations and outcome expectations (Bandura, 1986). Efficacy expectations are the belief an individual can carry out the desired behavior, and outcome expectations are the belief a behavior will result in a specific desired outcome (Bandura, 1986; Bandura, 1998). As self-efficacy increases for a specific behavioral skill, the individual is more likely to use personal resources to maintain that skill (Bandura, 1986; Bandura, 1998;, 2005).

Teacher PD Evaluation

Evaluation instruments can be measured using qualitative or quantitative methods; however, quantitative Likert-scale items are more commonly used, possibly due to the ease of validity and reliability for this type of evaluation (Rossi, Lipsey & Freeman, 2004). There are various professional development evaluation tools and guides available for researchers to assess program effectiveness; however, the available resources do not focus on teacher satisfaction or motivation despite identification as essential for transfer of knowledge and skills (Gorozidis & Papaioannou, 2014).

The Centre for the Study of Learning and Performance provides its Cooperative Learning Implementation Questionnaire (CLIQ). The Centre developed this tool to promote effective classroom practices through active participation with schools, administrators, and teachers; however, this resource contains 68 items, which could be cumbersome for PD participants potentially leading to item nonresponse error as a result of respondent fatigue. Respondent fatigue thus potentially compromises the validity of items, especially those appearing near the end of the instrument (Peytchev, 2009).

Vanderbilt's IRIS Center provides resources for teachers and PD developers regarding PD evaluation; however, they do not provide a specific evaluation tool for developers to utilize. Instead, the Center provides detailed information and a sample guide for developers to use when creating their PD experience and evaluation tool. The suggested components to include in an evaluation survey are (a) participants' reactions, (b) participants' learning, (c) organization support and change, (d) participants' use of new knowledge, and (e) student learning outcomes (Vanderbilt IRIS, n.d.).

North Carolina State University's (NCSU) Friday Institute created a 17-item evaluation tool for PD developers to utilize for evaluating program effectiveness specific to formative evaluation. The first 12 items address participant agreement with statements about the PD experience, while the second portion asks open-ended questions. This tool is available for non-commercial use; however, the data collected from this tool must be made available to the Friday Institute for additional reliability and validity purposes, which may be a deterrent for deployment in some entities (Friday Institute, 2019).

Methodology

Study Design

This study examined the secondary data analysis of the FoodMASTER Initiative's development and validation of an electronically administered satisfaction survey designed to evaluate teacher satisfaction of multidisciplinary professional development experiences for science and mathematics teachers. This was a non-experimental, cross-sectional non-longitudinal survey design as deemed appropriate for social science research (Creswell & Poth, 2017). The survey underwent validity and reliability measures. See Figure 3.2 for these measures. Data was gathered from STEM teachers attending the 18th Annual Summer Institute for K-12 Teachers in Texas. The survey underwent statistical measures to ensure reliability and validity. These measures can be found in figure 3.2.

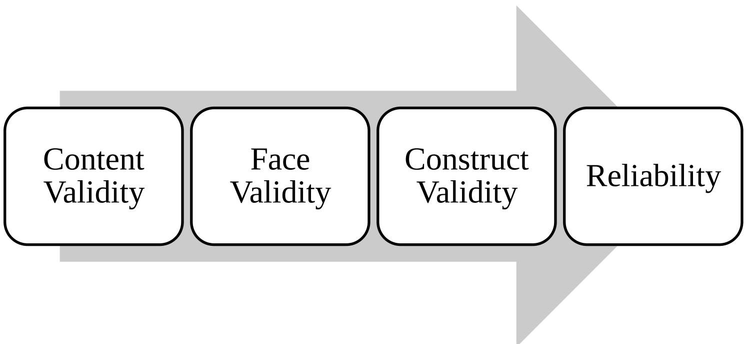

Figure 3.2 Satisfaction survey validation

Program Description

The FoodMASTER Initiative is a compilation of curricula aimed at using food as a tool to teach mathematics and science. FoodMASTER provides resources for teachers to use in the K-12 classroom. Currently, the program offers curricula for grades three to five, six to eight and higher education; however, programming can be utilized in a variety of K-12 settings as evidenced by years of teacher feedback and program analysis. As part of this curricular initiative, a 21-item professional development assessment instrument was developed to determine teacher PD effectiveness. Responses to this 21-item instrument was used to guide the creation of a valid and reliable instrument suitable for use in similar professional development settings.

Participants

The survey instrument was provided to participating educators in the 18th Annual Summer Institute for K-12 Teachers in Texas for validation and reliability. The K-12 Summer Institute is a NIGMS SEPA initiative aimed at introducing new and innovative STEM-based programs teachers can use in the classrooms. The Summer Institute provides a free four-day PD experience in Kerrville, Texas every summer. The institute also offers teachers the opportunity to apply for a travel grant if the cost of lodging is not manageable.

This population was selected due to its (a) affiliation with NIGMS SEPA, and (b) target audience of STEM teachers with approximately 200 teachers attending four, day-long PD workshops yearly. Participants were asked to complete the online survey for each of the four workshops attending for a potential total of 800 responses. Based on the total population, the final sample size required to validate this survey instrument was 242 responses, which achieves 95 percent confidence with a ten percent margin of error (Kadam & Bhalerao, 2010).

Instrumentation

The instrument for this study was a researcher-developed online survey comprised of 21 items. The survey began as FoodMASTER PD Evaluation Survey, which was piloted with 21 teachers in March 2019; however, after testing and feedback from science education experts as well as extensive literature research, the survey required modification to focus primarily on the participant satisfaction. See Table 3.1 for survey item inclusion justification.

Table 3.1
Survey Item Justification

Question	Justification
PART II: Level of Agreement	
The instructor(s) was/were:	PD instructor questions are necessary for teachers to respect the instructor enough to be willing to implement the curricula in their own classroom.
1. organized	A lack of organization could lead to a reduction in participant confidence in the instructor's knowledge and skills.
2. prepared	A lack of preparedness is likely to prevent the transfer of knowledge.
3. responsive to questions and concerns	Teachers need to feel comfortable to ask questions and express concerns.
4. effective in delivering information	Lack of effective teaching strategies will prevent the transfer of knowledge.
5. able to convey ideas for classroom implementation	Provides teacher with more justification to respect the instructors based on their ability to express feasibility of classroom implementation.

Table 3.1 (continued)

The workshop:	Perceptions regarding the PD workshop itself are necessary to understand the effective aspects of the workshop.
6. met my expectations	If participant expectations are not met, it is less likely they will implement what was learned.
7. objectives were met	A workshop training experience is not effective at meeting its objectives if the teachers do not perceive they have been met.
8. was timely	Timeliness should be addressed to assess value.
9. was relevant to my practice	Relevancy relates to program characteristics, and must be relevant for teachers to implement the materials presented.
10. resources will help me implement the content in my classroom	Resources provided will help teachers take the knowledge and skills gained from the workshop to implement in their classrooms.
11. helped me gain new knowledge I will use in the classroom	Teachers' perceptions of the workshop experience provided them with the necessary knowledge and skills to implement in the classroom will enlighten motivation.
12. helped me gain new skills I will use in the classroom	
PART III: Perceived Value and Quality	
13. The instructors(s) curricular material knowledge	Providing teachers with the opportunity to evaluate the quality of the instructor's knowledge and skills goes beyond level of agreement and provides necessary information to determine the appropriateness of the instructor, or if improvement needs to be made.
14. The instructor(s) background foundation knowledge	A strong instructor foundation knowledge is needed to adequately answer teacher questions.
15. Your impression of the overall quality of the course materials	Quality materials are necessary for teachers to feel prepared to implement in their classroom.
Please rate your confidence in:	
16. your knowledge regarding the information introduced in today's workshop at the end of the day	Confidence in their knowledge and skills will help understand their ability and motivation to implement in their classrooms.
17. your ability to perform the skills introduced in today's workshop at the end of the day	
PART IV: Open-Ended Questions	
18. What was the most significant aspect of this WS that you will apply in your classroom? Why?	Provides teachers with the opportunity to reflect upon the workshop and how they will apply that information in their classroom, which leads to a better likelihood of classroom implementation.
19. What were the strengths of this workshop?	Provides feedback to developers regarding components that were most effective for continued use in future PD experiences.
20. What were the weaknesses of this workshop?	Provides feedback to developers regarding components that were least effective for discontinued use in future PD experiences.
21. Please provide any additional thoughts regarding your workshop experience or ideas you have for the program.	Provides an opportunity for teachers to provide additional feedback potentially not captured in the existing questions.

The survey was developed using suggested satisfaction components from the Vanderbilt IRIS Center's Five Critical Levels of Professional Development Evaluation. This guide follows a similar structure to Kirkpatrick's four levels of evaluation; however, it also includes organization support and change as a component. The survey developed for this study, however, focuses on the first level, participant reactions through satisfaction, to better determine participant satisfaction and gain insight in to teacher engagement for future PD programs. No matter what subject matter is being offered, if PD programs do not meet participant needs, teachers will not be likely to implement the knowledge or skills being presented (Guskey, 2000). Table 3.2 aligns survey items with their intended measurement component.

Table 3.2
Satisfaction Survey Item Alignment

		Satisfaction	
Question	**Reactions**	**Motivation**	**Program Characteristics**
Please indicate your level of agreement with the following statements.			
The instructor(s) was/were:			
1. organized	X		
2. prepared	X		
3. responsive to questions and concerns	X		
4. effective in delivering information	X		
5. able to convey ideas for classroom implementation	X		
The workshop:			
6. met my expectations	X		X
7. objectives were met	X		X
8. was timely	X		X
9. was relevant to my practice	X		X
10. resources will help me implement the content in my classroom			X
11. helped me gain new knowledge I will use in the classroom		X	X
12. helped me gain new skills I will use in the classroom		X	X
Ranking Scores Evaluation			
Please rate the following on a scale of 1-5 with 1 being poor, and 5 being excellent.			
13. The instructors(s) curricular material knowledge and skills	X		
14. The instructor(s) background foundation knowledge	X		
15. Your impression of the overall quality of the course materials	X		X
Please rate your confidence in:			
16. your knowledge regarding the information introduced in today's workshop at the end of the day		X	
17. your ability to perform the skills introduced in today's workshop at the end of the day		X	

Table 3.2 (continued)

Open-Ended Questions				
18.	What was the most significant aspect of this WS that you will apply in your classroom? Why?	X	X	X
19.	What were the strengths of this workshop?	X		X
20.	What were the weaknesses of this workshop?	X		X
21.	Please provide any additional thoughts regarding your workshop experience or ideas you have for the program.	X		X

The 21-items were grouped in three sets of questions based on the response format. Items one through 12 used a five-point level of agreement Likert-scale. Items 12 through 17 used a five-point perceived value Likert-scale to rank participant responses. Items 18-21 were open-ended questions. Each group was preceded by instructions explaining how to respond. This is to clarify to the participant what is expected of them, which can remove ambiguity that could lead to inaccurate or incomplete responses (Groves et al., 2009). The first section included 12 questions which utilized a 5-point Likert scale ranging from Strongly Disagree to Strongly Agree for responses. This section primarily provided information on participant reactions to the PD facilitator, methods, and resources; however, additional questions also collected necessary motivation information based on the participants' likelihood to utilize the resources, knowledge, or skills in their classrooms.

The second section was comprised of six questions using a sliding scale ranging from poor to excellent. Participants were asked to rank their confidence before and after the PD experience and asked to elaborate on the rationale for their responses after the workshop. Confidence questions provided self-efficacy information essential to determining participant satisfaction. If participants were not confident in their ability to perform skills or apply knowledge, it is not likely the PD experience met their needs. The third section was open response, which provided participants with the opportunity to discuss strengths and weaknesses as well as the most significant component of the PD they will use in their classrooms. Questions in this section of the survey provided teachers with the opportunity to provide detailed candid feedback to PD developers.

The layout of the instrument was carefully ordered after review from STEM and education experts. The instrument was comprised of series of questions requiring thoughtful answers, broken up by more straightforward questions to prevent response fatigue and subsequent instrument breakoff by the participants (Peytchev, 2009). Asking efficacy questions may be sensitive information for some participants who do not want to reveal their intentions; however, positioning these items in the middle of the instrument and providing ranges from which to answer allows the participant to be more comfortable with the content of the instrument before having to respond to something more sensitive, which can improve the accuracy of the response (Tourangeau, Rips, & Rasinski, 2000).

Non-response error measures. There are several factors to consider when attempting to avoid unit non-response error. Respondent fatigue, specifically, can lead to non-response error making it imperative for the instrument questions and the answer choices to be succinct, but also include the necessary information needed by program developers to assess teacher satisfaction. Complex questions that would require several parts or steps to respond have been minimized or avoided. Answer choices were analyzed to limit confusion and ambiguity for participants.

When designing the questions and answers, survey developers were also aware of the potential issues that may occur as a result of the participant’s use of computer/laptop or smartphone; therefore, this instrument was easily accessible on the computer/laptop or smartphone (Antoun, Couper, & Conrad, 2017). For example, answer selections did not require scrolling to view, and sections of the instrument were separated easily into different pages on a mobile device to also limit the need for scrolling (Tourangeau, Conrad, & Couper, 2013).

Validity and reliability. Simply stated, a valid survey is one that measures what it claims it measures (Groves et al., 2009). Survey validation allows program developers to ensure their survey measures what they intend to measure. Without validation, data collected may not provide an accurate representation. There are, however, components to validity which should be used to determine survey validity including face validity, content validity, and construct validity (Groves et al., 2009).

Content validity. Content validity measures whether content experts agree the survey measures what it is intended to measure. Content validity for this instrument was assessed using two primary modes including professional development evaluation literature and NIGMS SEPA teacher PD principal investigator input.

Face validity. Face validity measures whether the survey measures what it is intended to measure from the perspective of the intended user (Groves et al., 2009). The survey instrument in this study underwent face validity with a group of 20 to 25 STEM teachers prior to implementation at the K-12 Summer Institute.

Construct validity. Construct validity can be determined by conducting an exploratory factor analysis to inform the extent to which an item fits well with its intended subscale. Exploratory factor analysis determines whether survey items are correlated by establishing the factor structure which would represent the variable as a valid construct (Groves et al., 2009). Exploratory factor analysis was employed to determine if the intended subscales reactions, motivation, and program characteristics, were being measured.

Reliability. Reliability is the degree to which a technique applied multiple times yields the same result each time. Cronbach's Alpha is commonly used to measure internal consistency, which is how closely related a set of items are as group.

Results

The purpose of this study was to design and implement a tool to answer the following research questions:

1. What is the factor structure and reliability of the teacher satisfaction survey?

The results presented in this study will discuss the response rate, demographics, factor analysis, reliability, and propose the final survey instrument. The final instrument can be utilized as warranted by grant-funded STEM education programs where teacher PD is a component.

Response Rate

There were approximately 200 participants in attendance at the NIGMS SEPA funded 18th Annual Summer Institute for K-12 Educators. Participants attended one workshop for each of the four days and were asked to provide feedback about each of the four workshops. The survey was provided to participants online using Qualtrics. Participants were provided with a direct link to the survey and asked to complete it at the end of each PD workshop. The total number of survey respondents included 644 responses resulting in an 80.5 percent response rate; however, some of the respondents did not answer all survey questions. Descriptive demographic statistics (gender/sex, age, race, ethnicity) were provided for the respondents of which answered particular questions and can be found in Table 3.3. Subscale scores for factors were only calculated for respondents who answered all the questions for that particular subscale.

Demographics

Demographic variables collected from respondents included gender, race, ethnicity, age, profession, primary type of employment, location of employment, years of teaching experience, and highest degree obtained. All data was categorical and presented as frequencies in Table 3.3.

Table 3.3
Participant Demographic Frequencies

Variable	Category	Frequency	Valid Percent
Gender	Male	75	11.8
	Female	560	88.2
Race	African American	14	2.2
	Asian	7	1.1
	Caucasian	511	80.1
	American Indian/Alaska Native	8	1.3
	More than one race	30	4.7
	Other	68	10.7
Ethnicity	Hispanic or Latino	154	32.5
	Not Hispanic or Latino	320	67.5
Age	18-29	40	6.3
	30-39	130	20.5
	40-49	140	22.1
	50-59	214	33.8
	60-69	101	33.8
	70+	8	1.3
Profession	Teacher	585	91
	Community Educator	10	1.6
	Student	4	0.6
	Other	44	6.8
Primary Employer	Public School	580	91.9
	Private School	23	3.6
	Museum	1	0.2
	Other	27	4.3
Employment Location	Rural	212	33.9
	Urban	169	27
	Suburban	244	39
	Other	1	0.2
Years of Teaching Experience	1-3 years	78	12.3
	4-7 years	62	9.8
	8-10 years	74	11.7
	10-15 years	104	16.4
	15+ years	311	49.1
	NA	4	0.6
Highest Education Level Obtained	Associate's Degree	9	1.4
	Bachelor's Degree	339	54.2
	Some graduate courses	92	14.7
	Master's Degree	172	27.5
	Doctoral Degree	6	1.0
	Other	8	1.3

Factor Analysis

The purpose of this study was to validate a teacher PD satisfaction survey. Responses to this 21-item instrument were used to guide the creation of a valid and reliable instrument suitable for use in similar professional development settings. This survey was comprised of three sections:

1. Level of Agreement: items one through 12 used a five-point level of agreement Likert-scale.
2. Perceived value: Items 12 through 17 use a five-point perceived value Likert-scale.
3. Open Response: Items 18-21 were open-ended questions

The first two sections underwent factor analysis with the third section only undergoing content and face validity.

Likert-scale level of agreement items. An exploratory factor analysis was employed using principal components analysis with varimax rotation for items one though twelve. Three factors, reactions, motivation, and program characteristic subscales were intended to be extracted. The exploratory analysis, however, yielded two factors which met the (eigenvalue criteria >1) and explained 74.5 percent of the variance as shown in Table 3.4. Note, however, that this amount of variance is not equally distributed among the two factors detected through exploratory factor analysis. The first factor explained 58.4% of the variance, while the second factor explained the remaining 16.1% of variance.

Table 3.4

Total Variance Explained by Anticipated Factors: Level of Agreement

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.746	60.419	60.419	7.014	58.449	58.449	5.098	42.479	42.479
2	1.686	15.100	75.519	1.932	16.103	74.552	3.849	32.072	74.552

Table 3.5 outlines factor loadings based on the exploratory analysis. The first of these subscales included the initial eight items including *the instructor(s) was/were: organized, prepared, responsive to questions and concerns, effective in delivering information, able to convey ideas for classroom implementation*; and *the workshop: met my expectations, objectives were met, was timely*. However, the sixth item, *the workshop met my expectations*, resulted in factor loadings that, although more closely aligned with the first subscale, reveals considerable overlap with the second subscale. Albeit subtle, this sixth item is more multidimensional than other items since it demands the respondent compare their expectations with what was delivered by either the individual facilitator or the broader PD program. In other words, whereas most items focus solely on either the facilitator or the participant, item six focuses on both in a combined fashion. The remaining seven items in the second subscale dealt with characteristics which were under the control of the workshop facilitator and were primarily participant reactions to the facilitator. By contrast, whether or not the workshop met the participant's expectations is largely dependent upon the participant herself or himself. The last four items which were clearly learner-centered, loaded on the motivation subscale involved perceptions heavily dependent upon the individual participant.

Table 3.5

Rotated Component Matrix Factor Loadings: Level of Agreement

Item	Component 1	Component 2
The Instructor was organized.	**.887**	.226
The Instructor was prepared.	**.884**	.221
The Instructor was responsive to questions and concerns.	**.795**	.091
The Instructor was effective in delivering information.	**.840**	.238
The Instructor was able to convey ideas for classroom implementation.	**.774**	.341
The workshop met my expectations.	**.608**	.554
The workshop objectives were met.	**.701**	.434
The workshop was timely.	**.698**	.410
The workshop was relevant to my practice.	.208	**.845**
The workshop resources will help me implement the content in my classroom.	.225	**.896**
The workshop helped me gain new knowledge I will use in the classroom.	.319	**.793**
The workshop helped me gain new skills I will use in the classroom.	.222	**.871**

Since the exploratory factor analysis yielded only two distinct subscales instead of the initially intended three, a confirmatory analysis was also employed. The confirmatory analysis using the intended three factors revealed the third component eigenvalue was 0.618 and the three components explained 81% of the variance in contrast to the original 75%. See Table 3.6. Considering the significant difference in eigenvalue and little difference in variance when compared to the second factor, the third factor was not retained.

Table 3.6

Total Variance Explained by Confirmatory Factor Analysis: Level of Agreement

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	6.746	60.419	60.419	7.014	58.449	58.449	5.098	42.479	42.479
2	1.686	15.100	75.519	1.932	16.103	74.552	3.849	32.072	74.552
3	.618	5.539	81.057	.618	5.539	81.057	2.070	17.247	80.050

The final factor solution included two factors, reactions and motivation. The third anticipated factor, program characteristics can be explained by the first two factors. Items which loaded upon the third factor included, *the workshop met my expectations, the workshop objectives were met,* and *the workshop was timely*. All three items are program characteristics; however, each could also be considered a reaction to the workshop experience. See Table 3.7 for details.

Table 3.7
Confirmatory Factor Analysis Rotated Component Matrix Factor Loadings: Level of Agreement

Item	Component		
	1	2	3
The Instructor was organized.	**.837**	.199	.338
The Instructor was prepared.	**.841**	.198	.316
The Instructor was responsive to questions and concerns.	**.845**	.084	.151
The Instructor was effective in delivering information.	**.848**	.249	.198
The Instructor was able to convey ideas for classroom implementation.	**.730**	.355	.246
The workshop met my expectations.	.335	.430	**.758**
The workshop objectives were met.	.428	.297	**.789**
The workshop was timely.	.509	.340	**.550**
The workshop was relevant to my practice.	.198	**.819**	.174
The workshop resources will help me implement the content in my classroom.	.228	**.880**	.157
The workshop helped me gain new knowledge I will use in the classroom.	.210	**.771**	.350
The workshop helped me gain new skills I will use in the classroom.	.166	**.862**	.238

The final factor solution resulted in retaining the two factors as a result of the exploratory factor analysis due to the low eigenvalue for the third factor, as well as the potential of the third factor being explained by reactions. See Table 3.8 for the proposed subscale loadings for a visual comparison.

Table 3.8

Final Factor Solution: Level of Agreement

Factor	Item	Component 1	Component 2
1. Reactions	The Instructor was organized.	**.887**	.226
	The Instructor was prepared.	**.884**	.221
	The Instructor was responsive to questions and concerns.	**.795**	.091
	The Instructor was effective in delivering information.	**.840**	.238
	The Instructor was able to convey ideas for classroom implementation.	**.774**	.341
	The workshop objectives were met.	**.701**	.434
	The workshop was timely.	**.698**	.410
	The workshop met my expectations.	**.608**	.554
2. Motivation	The workshop was relevant to my practice.	.208	**.845**
	The workshop resources will help me implement the content in my classroom.	.225	**.896**
	The workshop helped me gain new knowledge I will use in the classroom.	.319	**.793**
	The workshop helped me gain new skills I will use in the classroom.	.222	**.871**

Likert-scale perceived value items. An exploratory factor analysis was employed using principal components analysis with varimax rotation for items thirteen through seventeen. The exploratory process did not produce the anticipated number of subscales to extract statistically with the initial analyses yielding only one component. The total variance explained by the first and sole factor accounted for 73.7% of the variance. See Table 3.9.

Table 3.9

Total Variance Explained by Confirmatory Factor Analysis: Perceived Value

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.687	73.739	73.739	3.687	73.739	73.739	1.960	3.687	73.739

One potential reason for only one factor loading is the general rule of needing three items per factor (Costello & Osborne, 2005). The number of questions in the perceived value of this section only encompassed five questions, leaving three items in one component and two in the other. Two factors were specified in a confirmatory factor analysis based on the similarities of the five questions to ensure the items loaded upon appropriate factors rather than one factor of truly unrelated items. These factors accounted for 89% of the total variance for these items. The second factor was kept due to the l6% increase in variance and an eigenvalue somewhat close to 1, the suggested cutoff point. See Table 3.10.

Table 3.10

Confirmatory Factor Analysis Total Variance Explained by Anticipated Factor: Perceived Value and Quality

Factor	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.687	73.739	73.739	3.687	73.739	73.739	2.259	3.687	73.739
2	.781	15.625	89.364	.781	15.625	89.364	2.210	.781	15.625

The first subscale included the two questions related to participant confidence, *Please rate your confidence in: your knowledge regarding the information introduced in today's workshop at the end of the day; your ability to perform the skills introduced in today's workshop at the end of the day;* and *your impression of the overall quality of the course materials.* The third item loaded similarly on the second factor indicating the item could measure both factors; however, the low factor loading in both components of 0.641 and 0.632 indicates this item may not be appropriate to include in the final survey. Table 3.11 outlines the factor loadings.

Table 3.11

Final Factor Solution: Perceived Value

Factor	Item	Component 1	Component 2
1. Reactions	The instructor(s) background foundation knowledge	.220	**.927**
	The instructors(s) curricular material knowledge	.363	**.883**
2. Motivation	Your impression of the overall quality of the course materials	**.641**	.636
	Your confidence in your knowledge regarding the information introduced in today's workshop at the end of the day	**.896**	.331
	Your confidence your ability to perform the skills introduced in today's workshop at the end of the day	**.930**	.242

Construct Reliability

Cronbach's alpha was employed to examine the internal reliability within each intended subscale, thus informing the relative reproducibility of similar results within the broader population. One general "rule of thumb" for a satisfactory Cronbach's alpha threshold is 0.70 for social science research (Garson, 2008). The analysis yielded a Cronbach's alpha greater than zero for both factors. The first set of questions using level of agreement loaded upon two factors, reactions and motivation. The reliability of items 1-8 (0.935) was higher than 9-12 (0.910) with both meeting the 0.70 or higher threshold for social science. The perceived value and quality section factors, reactions and motivation, Cronbach's alphas were both acceptable; however, the output revealed if item 15, *Your impression of the overall quality of the course materials*, was deleted from the motivation factor, reliability would increase from 0.907 to 0.925. Considering the low factor analysis values and increased reliability, item number 15 was removed from the final survey. See Table 3.12.

Table 3.12
Estimated Reliability of Constructs

Factor	Items on EPDSS	Cronbach's Alpha
Level of Agreement		
Factor 1: Reactions	Items 1-8	0.935
Factor 2: Motivation	Items 9-12	0.910
Perceived Value		
Factor 1: Reactions	Items 13-14	0.910
Factor 2: Motivation	Items 16-17	0.925

Final Instrument

The exploratory factor analysis and reliability analysis prompted and informed minor revisions to the proposed survey. The proposed EPDSS included three factors, reactions, motivation, and program characteristics; however, the exploratory factor analysis detected only two factors given survey response patterns. Based on a subjective review of these results, the revised structure focuses on two factors (a) reactions, and (b) motivation. Table 3.13 illustrates these modifications. Items indicated with an X aligned as intended; items indicated with a Y were items originally intended to measure program characteristics.

The first twelve items utilized a five-point Likert-scale level of agreement from strongly disagree (1) to strongly agree (5) for responses. The mean for each of these items is summarized in Table 3.14. *The Instructor was responsive to questions and concerns* had the highest mean score of 4.8106, while *the workshop was relevant to my practice* yielded the lowest mean score of 4.4689. Note, however, that all these means reflect a perceived level of agreement that falls between *Agree* and *Strongly Agree*.

Table 3.13

Final Satisfaction Survey Item Alignment

Question	Satisfaction: Reactions	Satisfaction: Motivation
LEVEL OF AGREEMENT		
The instructor(s) was/were:		
1. organized	X	
2. prepared	X	
3. responsive to questions and concerns	X	
4. effective in delivering information	X	
5. able to convey ideas for classroom implementation	X	
The workshop:		
6. met my expectations	Y	
7. objectives were met	Y	
8. was timely	Y	
9. was relevant to my practice		X
10. resources will help me implement the content in my classroom		X
11. helped me gain new knowledge I will use in the classroom		X
12. helped me gain new skills I will use in the classroom		X
PERCEIVED VALUE AND QUALITY		
13. The instructors(s) curricular material knowledge and skills	X	
14. The instructor(s) background foundation knowledge	X	
Please rate your confidence in:		
15. your knowledge regarding the information introduced in today's workshop at the end of the day	X	
16. your ability to perform the skills introduced in today's workshop at the end of the day	X	

Table 3.14

Level of Agreement Means

Variable	N	Minimum	Maximum	Mean	Std. Deviation
The Instructor was responsive to questions and concerns.	623	1.00	5.00	4.81	.71
The Instructor was organized.	626	1.00	5.00	4.74	.77
The Instructor was prepared.	623	1.00	5.00	4.73	.83
The workshop objectives were met.	625	1.00	5.00	4.72	.81
The Instructor was effective in delivering information.	624	1.00	5.00	4.70	.85
The Instructor was able to convey ideas for classroom implementation.	624	1.00	5.00	4.68	.95
The workshop was timely.	625	1.00	5.00	4.63	1.00
The workshop met my expectations.	626	1.00	5.00	4.62	.91
The workshop helped me gain new knowledge I will use in the classroom.	615	1.00	5.00	4.56	1.05
The workshop helped me gain new skills I will use in the classroom.	616	1.00	5.00	4.52	1.14
The workshop resources will help me implement the content in my classroom.	623	1.00	5.00	4.48	1.21
The workshop was relevant to my practice.	627	1.00	5.00	4.47	1.20

The remaining five items utilized a five-point Likert-scale of perceived value and quality ranging from poor (1) to excellent (5) for responses. The mean for each of these items is summarized in Table 3.15. *The instructor(s) background foundation knowledge* scored highest with a mean score of 4.8426, while *Your confidence in your knowledge regarding the information introduced in today's workshop at the end of the day* scored lowest with a mean score of 4.6169.

Table 3.15 *Perceived Value Means*

	N	Minimum	Maximum	Mean	Std. Deviation
The instructor(s) background foundation knowledge	629	1.00	5.00	4.84	.50
The instructors(s) curricular material knowledge	629	1.00	5.00	4.80	.59
Your confidence in your knowledge regarding the information introduced in today's workshop at the end of the day	629	1.00	5.00	4.62	.72
Your confidence in your ability to perform the skills introduced in today's workshop at the end of the day	628	1.00	5.00	4.62	.71

Discussion and Implications

The purpose of this study was to explore the validity and reliability of a teacher professional development survey to be utilized across the National Institute of General Medical Science (NIGMS), Science Education Partnership Award (SEPA) and similar teacher PD programs to provide continuity of evaluation and improve STEM teacher PD experiences. SEPA provides funding for innovative STEM-based projects aimed at students from pre-kindergarten through grade 12 as well Informal Science Education (ISE) projects. These programs connect biomedical and clinical researchers with practitioners such as teachers, schools, museums, and science centers (ww.nihsepa.org).

An area of interest for these programs includes addressing the lack of diversity in the STEM workforce, which begins with engaging K-12 students in STEM subjects before pursuit of post-secondary education (Perry, Link, Boelter, Leukefeld, 2012). Teachers are an ideal target audience for engaging K-12 students due to the vast amount of time spent with students during school hours. On average, teachers spend over 1200 hours with K-12 students each year, which provides a great deal of time to better engage K-12 students in STEM subjects. To adequately prepare teachers, targeted professional development experiences should be employed (Loucks-Horsley et al., 2010); however, without validated evaluation methods, these experiences may not produce the intended outcomes.

While there are existing validated PD evaluation instruments available for use (IRIS, n.d., research focusing on teacher thoughts and perceptions regarding their professional development experience is limited (Till et al., 2011). Despite the importance of understanding teacher satisfaction with PD experiences, many evaluation methods and instruments have restricted the amount of satisfaction information collected in STEM and health science (Frechtling et al., 1995; Guskey, 2000). Research has shown, however, that if teachers are not satisfied with the PD experience, they are less likely to implement what was learned (Nasser & Shabti, 2009; Gorozidis & Papaioannou, 2014). Validating a satisfaction-based survey instrument for SEPA programs, and similar initiatives is the first step in ensuring these projects meet the intended teacher PD outcomes.

Implications

With the current lack of focus on teacher satisfaction, it is crucial to develop a generalizable, valid, and reliable tool to assess participant reactions to and satisfaction with STEM PD experiences (Till et al., 2011; Nasser & Shabti, 2009; Nir & Bogler, 2008). Satisfied teachers are more likely to implement knowledge and skills gained in their classrooms, which will increase K-12 student engagement in STEM content. If we want to diversify the STEM workforce, we need to start with teachers. If teachers are satisfied and feel prepared to implement hands-on application-based STEM activities, UM K-12 students should display improvements in achievement and persistence in STEM career fields diversifying the workforce (Hulleman & Harackiewicz, 2009; Fleischer, Wemhoff, Obrien, Ural, & Alaways, 2010; Perry et al., 2012).

Employing a valid and reliable K-12 teacher PD satisfaction survey across scientist and clinician developed PD experiences can have a pronounced impact on these offerings. Understanding what teachers need from PD experiences to transfer knowledge gained during the experience is essential to impacting K-12 student attainment, especially for UM K-12 students. With the anticipated increase in demand for STEM careers and the alarmingly low percentage of UM groups in these careers, finding effective methods for preparing teachers to better engage these K-12 students is essential to diversify the workforce, especially in health professions and biomedical sciences. Considering demographic trends are indicating 50 percent of the population will be what is now considered minority by 2050, it is essential for biomedical and health professions to increase their efforts to recruit and retain minority groups (Smedley, Colburn & Evans, 2001). A more diverse health professional workforce will ultimately increase cultural competency, provide greater access for minority patients, and increase health care administrator knowledge about diverse populations resulting in better responsiveness to their needs (Beach et al., 2005).

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CHAPTER FOUR: In-service Teacher Perceptions of a Food and Nutrition Professional Development Workshop

Abstract

This essay utilized a secondary data analysis to explore participant professional perceptions about the quality of a food and nutrition teacher professional development (PD) workshop. This secondary data analysis examined results from an observation, focus groups, and a satisfaction survey. Evaluation tools utilized components of process evaluation to provide the necessary information to inform future program improvement. These components included fidelity, dose received (satisfaction), dose delivered (completeness), and context. The goal of process evaluation is to discover quality assurance information for program developers to ensure participants are receiving the intended information. Overall, FoodMASTER FAN PD workshop participants reported a positive experience; in fact, when asked to compare their confidence before and after the workshop, participants reported gains in confidence. Considering the overall participant satisfaction with the format of the workshop and useful feedback gained as a result of triangulation, similar PD developers should implement comparable efforts to ensure the provision of satisfactory PD programming.

Keywords: K-12 teacher, STEM, in-service teacher professional development, process evaluation, application-based, hands-on

Introduction

Engagement in in-service teacher professional development is essential for educators to continue effective in instruction. Darling-Hammond et al. (2009) stated "well-designed professional learning helps teachers master content, hone teaching skills, evaluate their own and their students' performance, and address changes needed in [their] teaching and learning" (7). This thought process places an emphasis on ensuring professional learning experiences are satisfactory and effective.

Effective teacher professional development (PD) workshops are comprised of a wide variety of methods and approaches to achieve quality outcomes. This study employed a secondary data analysis of observations, focus groups, and a satisfaction survey to determine the quality indicators of a specific workshop that was offered at the Dupage County Illinois Teacher Institute in March 2019. The workshop selected to review was the FoodMASTER Initiative, a National Institutes of General Medical Sciences (NIGMS) Science Education Partnership Award (SEPA) funded program. This program was selected for evaluation in order to improve the design and delivery of future programming. This study employed mixed methods to analyze qualitative and quantitative data to answer the following research questions:

1. What were participant perceptions about the PD workshop?
    a. What aspects of the PD workshop should be continued?
    b. What aspects of the PD workshop should be discontinued?
    c. How does this PD workshop compare to other experiences?
2. What components of process evaluation were met during the PD workshop?
3. How were the identified process evaluation components met during the PD workshop?
    a. Was the PD workshop implemented as intended?
    b. Were the participants satisfied with the PD workshop?
    c. Was the PD workshop completed as intended?
    d. Was the context appropriate and clear?

This secondary data analysis provides the National Institutes of General Medical Sciences (NIGMS) Science Education Partnership Award (SEPA) FoodMASTER Initiative with an evaluation of participants perceptions of the quality of the workshop offering through a non-biased, external review of the teacher PD offering to inform subsequent teacher PD design.

Literature Review

Aspects of Teacher Professional Development

Teacher professional development should include a focus on K-12 student needs and learning (Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010). Strong evidence of improvement in K-12 student learning outcomes is a key element for a significant change in teachers' attitudes and beliefs (Guskey, 2002). Creating effective teacher professional development experiences should be purposeful in both aim and content as well as employ engaging methods for implementation. Based on previous research, Desimone (2009) has identified content focus, active learning, coherence, duration, and collective participation as critical features of professional development.

Content focus. The content focus of teacher PD may be the most important component. Teachers must have a strong content background to improve K-12 student achievement (Desimone, 2009). Content focus should emphasize deepening teachers' content knowledge in the subject being presented. Focusing on content and how K-12 students learn the content has been shown to be an effective approach for teacher PD (Desimone, 2009; Garet, Porter, Desimone, Birman, Kwang & Yoon, 2001). Consequently, teacher PD experiences must also consider the current research and knowledge base surrounding learners and learning. PD which requires teachers to reflect on how K-12 students learn have shown to be more effective at helping teachers better understand how and why different instructional strategies are more effective, which will ultimately provide a more impactful learning experience for K-12 students (Loucks-Horsley et al, 2010).

Active learning. Teachers need to be actively engaged in the professional development process through meaningful discussion, planning, and practice (Desimone, 2009). Active learning can take many different forms from observing experts, taking part in planning how to implement new curricular materials and methods in their classrooms, and leading discussions. Specifically, professional development experiences which offer teachers the opportunity to present, lead, and/or write allows teachers to delve deeper into the process and become more immersed in the experience (Garet et al., 2001). Successful professional development programs grounded in research-based knowledge about student learning focus on what the K-12 students are going to learn in the classroom as well as solutions for potential problems that these students may have in the classroom. Combined, content focus and active learning are characteristics of professional development that have a noteworthy impact on knowledge (Ingvarson et al., 2005).

Coherence. The extent to which teachers perceive professional development activities to be part of a coherent program of teacher learning is another core component of effective teacher PD (Desimone, 2009; Garet et al., 2001). Teachers often criticize PD experiences when the activities seem disconnected from one another and do not appear to be a part of a coherent program aimed at teacher learning and development (Garet et al., 2001). Teachers need to be able to see the big picture, not only how the individual activities connect with one another, but also how they connect with their curriculum, as well as the content standards and assessments required for teaching. Understanding the standards and values of the teacher, school, district, and states are essential for ensuring coherence (Desimone, 2009; Garet et al., 2001).

Duration. Total time spent completing an activity, whether it be in one sitting or spread out over time, needs to be assessed to ensure mastery of knowledge and skills; however, research has not identified a specific time frame needed to master content. It has been suggested greater than 20 hours spread out over time is most effective (Desimone, 2009). Intensive professional development experiences are more effective when they are spread out over time and support collaboration amongst participants (Opfer & Pedder, 2011).

Collective participation. Building a meaningful network through actively engaging with teachers from the same school or teaching the same subject matter is premise of collective participation and provides a linkage to coherence. Building a community of teachers from the same school or teaching the same subject matter can promote coherence and active learning, which can result in increased teacher knowledge and skills practices in the classroom (Garet et al., 2001). Teachers from the same school or district are more likely to support each other through continued engagement in the implementation process. They can contribute to a shared professional culture which can promote a common understanding of instructional goals and methods (Talbert & McLaughlin, 1993).

Program Evaluation

Impact assessment, also referred to as outcomes assessment, identifies the extent by which a program has impacted its intended audience. This method has been considered the gold standard for evaluating program success (Bartholomew, Parcel, Kok, & Gottlieb, 2001); however, process evaluation has been identified as another common method for evaluating program success. Process evaluation allows researchers to determine why a program was or was not successful (Bartholomew, Parcel, Kok, & Gottlieb, 2001; Rossi, Lipsey, & Freeman, 2004). Employing process evaluation methods allows for improvement in program design and adaptability to the target audience and environment (Hoelscher, Evans, Parcel, & Kelder, 2002).

Evaluation of PD programming can be focused on planning, summative, and formative assessment. Guskey (2002) outlined critical levels of professional development evaluation adapted by Kirkpatrick's (1994) model for evaluating business and industry training programs. The five levels are hierarchical in nature from simple to more complex with each level building upon the former. The hierarchical levels include participants' reactions, participants' learning, organization support and change, participants' use of new knowledge and skills, and K-12 student learning outcomes. Oftentimes levels are omitted leading to less reliable evaluation information indicating a need to begin with the first level and work toward the final level to determine PD effectiveness.

Evaluation is necessary to determine why a program is or is not effective, and what needs to be done to improve outcomes. Process evaluation, a form of program evaluation, focuses specifically on implementation rather than a broader scope as suggested with Guskey's (2002) critical levels (Rossi et al., 2004). Researchers can engage in process evaluation to assess a variety of factors essential for understanding program effectiveness. Identified elements in recent health education include fidelity, dose received, dose delivered, context, reach, and recruitment (Schneider, et. al., 2009; Saunders, Evans, & Joshi, 2005). Fidelity distinguishes the extent by which a program was implemented as intended by its creators. Dose received assesses participant engagement and interaction with the program and its content. Dose delivered assesses the extent by which a program was completed in its entirety. Context reveals environmental factors which obstruct or promote program implementation; barriers or facilitators (Saunders et al., 2005). Reach refers to the number of participants in attendance. Combining the selected components can provide program developers with the necessary information to make improvements based on target audience needs (Rossi et al., 2004; Saunders et al., 2005).

Methodology

All methods in this study were approved by the North Carolina State University Institutional Review Board.

Rationale

Food science was selected as the educator professional development (PD) workshop theme because workshop providers are food and nutrition experts with an interest in improving food science knowledge and student engagement throughout K-12 learning environments. Working directly with K-12 educators is an opportunity to improve the public understanding of food ecology and nutrition. Design of the educator PD workshops began with selecting the FoodMASTER initiative curricula as a foundation for subject matter and content delivery. The rationale for selecting the FoodMASTER initiative curriculum as foundational material for the educator PD workshop was (1) FoodMASTER curricular materials were developed with teacher input; (2) FoodMASTER curricular materials have been implemented and evaluated in K-12 learning environments with positive gains in knowledge, attitude, and observed engagement; (3) the FoodMASTER content engages K-12 students in mathematics and science by using food as tool, something K-12 students have a preexisting contextual context with making these challenging subjects less discouraging; (4) materials can be accessed for free online; and (5) the FoodMASTER initiative was aiming to pilot test educator PD workshops as a means for reaching more educators with information about how to use the FoodMASTER initiative approach. See Table 4.1 for the description FoodMASTER teacher professional development workshop experience.

While the FoodMASTER initiative curriculum was used for the foundation of designing and delivering this educator PD workshop, providers recognize there are many quality resources for K-12 food science activities. At the end of the educator PD workshop, other resources were listed to ensure educators were aware of the wide range of potential food science education resources.

Program Theory

The FoodMASTER Initiative team considers it of utmost importance to provide an all-encompassing experience for participants which will engage them in the learning process through a variety of methods. Considering the intentions of the FoodMASTER PD workshop, its program theory presents the inputs, activities, outputs, and outcomes of the workshop.

Logic model

The overall picture of the FoodMASTER PD experience is outlined in its logic model. See Figure 4.1. The FoodMASTER PD workshop was held during the 2019 DuPage County Illinois Teacher Professional Development Institute Day. The workshop was designed as a six-hour continuing education experience for K-12 educators which introduced the broad scope of the FoodMASTER Initiative; free resources to teachers; and content specific lessons that included food safety, weights and measures, vegetables, fats and oils, and grains.

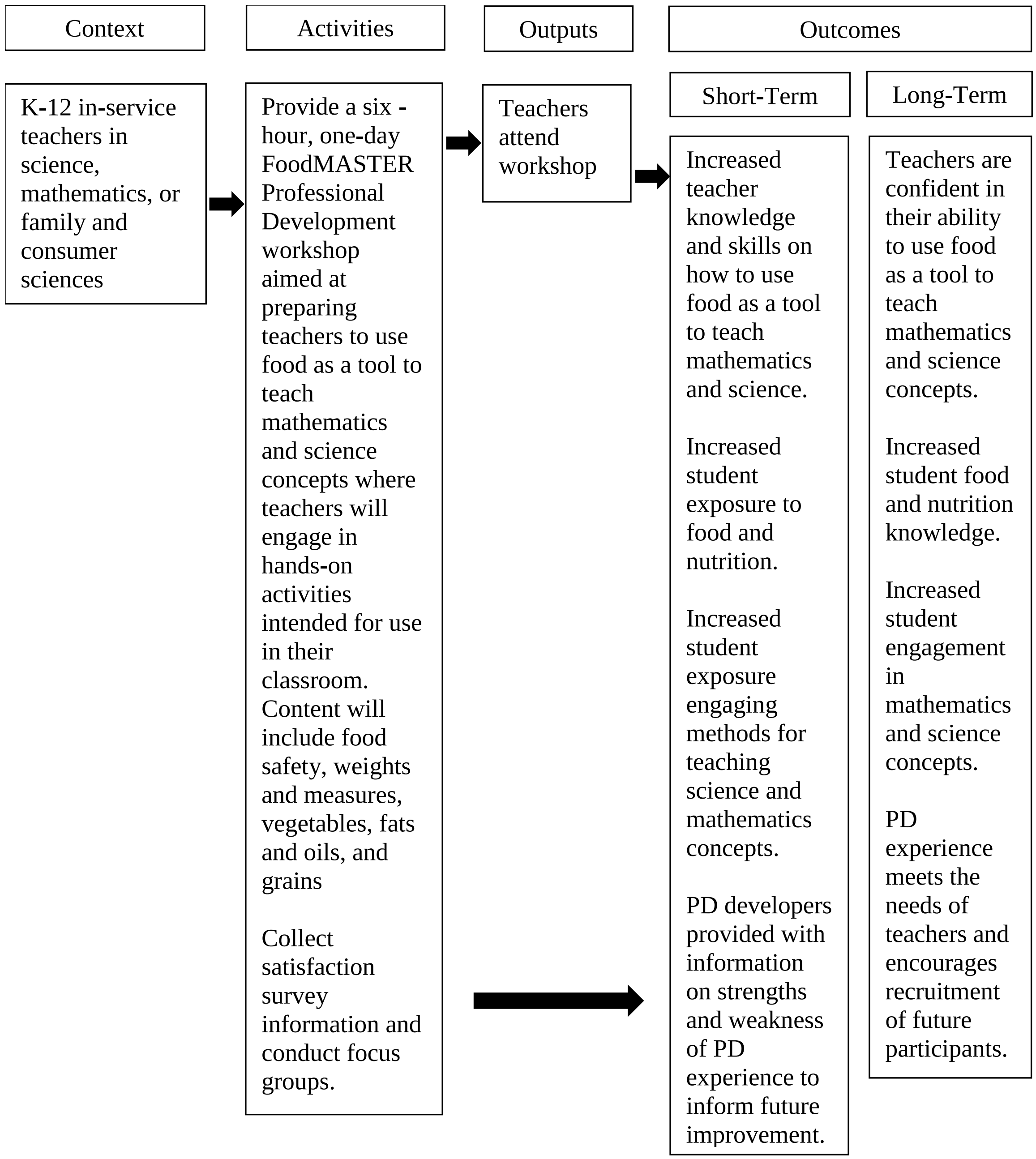

Figure 4.1 FoodMASTER professional development logic model

Context. K-12 in-service mathematics, science, or family and consumer science teachers are the target audience for this PD workshop. Teachers with a background in these topic areas are better prepared to implement the FoodMASTER activities in their classroom.

Activities. The FoodMASTER PD experience provided a workshop for teachers to encourage the use of food as a tool to teacher mathematics and science concepts. The workshop covered the broad scope of the FoodMASTER initiative; free resources to teachers; and content specific lessons which include food safety, weights and measures, vegetables, fats and oils, and grains.

Prior to the workshop beginning, teachers were asked to participate as research subjects in evaluating the workshop. Participating teachers received oral and written informed consent documents to be included in the study. All data collection procedures and documents were approved by the Northern Illinois University Institutional Review Board. Teacher participation in the study was completely voluntary and was not a requirement for participating in the FoodMASTER teacher PD workshop. Consenting teachers were provided with the satisfaction survey after completion of the workshop and asked to participate in focus groups.

Outputs. The primary output of this PD workshop was for teachers to physically attending the workshop.

Outcomes. Short-term outcomes are related to increased participant knowledge and skills as a result of participating in the training, and a gain in PD developer knowledge regarding teacher needs and satisfaction for future programming. Long-term outcomes are related to the participants' ability to implement the knowledge and skills acquired as a result of the training resulting in improved student outcomes, and the PD developers' ability to meet the needs of teachers and encourage recruitment of future participants. These outcomes most likely occured at least one-month post-implementation when the participants had been provided with numerous opportunities to apply the knowledge and skills gained. K-12 students were exposed to the intervention when workshop participants implemented workshop concepts in their classrooms.

The program theory assumes preparing teachers to use food as a tool in the classroom setting will increase participant knowledge and self-efficacy with the anticipated long-term result of increased K-12 student engagement in mathematics and science concepts.

Participants

The FoodMASTER (FM) food and nutrition professional development experience, a six-hour workshop, was held at Benedictine University in Naperville, Illinois on March 1, 2019. See Table 3.1 for the workshop agenda with topic descriptions and time needed for each component. The FM Director (FMD), Melani Duffrin and a consultant, the author, were the workshop hosts with a Northern Illinois University undergraduate nutrition and dietetics student serving as the workshop observer. DuPage County teachers were invited to attend the free workshop as a part of their annual Institute Day where they were given the opportunity to attend professional development experiences during regular school hours.

A total of 25 teachers attended the FoodMASTER workshop; however, not all teachers consented to participate in research. The final sample included 21 teachers of whom completed the workshop evaluation survey and observations with 15 of the 21 who consented to participate in the focus groups. Of the 21 consenting participants 9.5 percent were male (n=2), 90.5 percent female (n=19), 14.3 percent identified as Asian (n=3), 17 percent Caucasian (n=17), and 4.8 percent other (n=1). Years of teaching experience ranged from one to three years to 15-plus with grades Kindergarten (n=1), first (n=1), second (n-1), fourth (n=3), fifth through eighth (n-6), seventh through ninth (n=2), and ninth through twelfth (n=5) being taught. Teachers also varied based on whether they taught in a public (n=11) or private (n=10) school and highest degree completed including Bachelor’s (n=5), some graduate (n=1), and Master’s (n=15).

Workshop proceedings. The workshop was open for attendance beginning at 7:30 AM where teachers were required sign in using the official Institute Day record log. Teachers needed to include their name, signature, and arrival time. During this time, teachers were also provided with a folder which included their materials for the day in the order based on the schedule. All recipes, instructions, and any additional necessary information were included in this folder. The official workshop began promptly at 8:00 AM and continued until 2:00 PM. The FMD began by providing an overview of the program and its curricula as well as acknowledged and described NIGMS' SEPA support. The FMD was the primary host for the day, with the author as support during hands-on activities and when clarifying questions regarding previous classroom implementation arose. The author was the FoodMASTER program coordinator during the middle school implementation and testing phase. She attended all classroom observations to test implementation fidelity; therefore, she was able to provide a unique perspective to teachers when questions arose regarding potential issues in the classroom.

The day was comprised of topic backgrounds being introduced to provide teachers with the necessary nutrition-based knowledge to carry out the hands-on activities. Topics covered included food safety, weights and measures, vegetables, fats and oils, and grains. After each brief introduction to the subject, approximately 10 minutes of lecture, teachers were engaged in hands-on activities as if they were the student. During and after completion of the activities, teachers were encouraged to discuss how the activities would or would not work in their classrooms. To provide teachers with the opportunity to mimic a typical school day, the FoodMASTER team included lunch as part of the learning process by engaging teachers with discussion about how they could implement the morning's activities in their classrooms. After lunch, the FM team completed the day's activities with grains and engaged teachers in discussions about the events of the day to receive each of the following: teacher feedback regarding their satisfaction with the experience, suggestions for improvement, and their plans for implementing FM in their classrooms. This time was used as a debriefing to collect meaningful data in the form of focus groups. Teachers who did not provide consent to participate in the focus groups were provided with an alternative group discussion on the same topics to provide a collaborative environment. Once discussions were complete, the FMD thanked teachers for attending, welcomed any final questions or concerns, and asked consenting teachers to fill out the satisfaction survey. Teachers signed out stating their end of day time on the sign-in sheet completing the day's events.

Table 4.1
FoodMASTER PD Workshop Schedule

Setting: The workshop took place in student center at Benedictine University in Naperville, IL. Tables in the room were arranged so teachers could work in groups with a presentation and demonstration table at the front of the room. During each of the hands-on activities the FoodMASTER (FM) team walked around the different groups answering questions and discussing ways teachers could implement the activity in their classrooms.

Time	**Activity**	**Activity Description**
7:30 – 8:00 AM	Registration	Teachers signed in with program assistants including their name, signature, and arrival time. Teachers were provided with a folder at registration which included their materials for the day in order based on the schedule. All recipes, instructions, and any necessary information were included in this folder.
8:00 – 8:20 AM	Introduction to FoodMASTER	FoodMASTER Director (FMD), Melani Duffrin, provided an overview of the program and its curricula as well as acknowledged and described NIGMS' SEPA support.
8:20 – 8:55 AM	First Topic: Food Safety	FMD introduced the topic of food safety by providing a brief overview of the importance of practicing good food safety at home and at school, washing hands, and measuring temperatures when cooking.
8:55 – 9:45 AM	Weights and Measures	FMD provided overview of weights and measures content important for understanding how to accurately measure baked goods. Teachers then made no bake cookies using the FMD and team's instructions.
9:45 – 10:50 AM	Vegetables	FMD reviewed basic science and preparation principles about vegetables including cutting methods, pigmentation and supertasters. First teachers were provided with a PTC taste strip (bitter compounds) to determine if they are a supertaster. Supertasters can have an aversion to vegetables due to the bitter compounds found in most vegetables. Teachers were then provided with vegetables to cut and use to prepare a salad they would eat after the next activity.

Table 4.1 (continued)

10:50 – 11:00 AM	BREAK	
11:00 – 11:45 AM	Fats and Oils	FMD reviewed information about fats including the types of fats and emulsions. The teachers were then provided with the materials to make a lava lamp emulsifier using a 20-ounce bottle, oil, water, and ground mustard. Next, teachers were provided with materials to make an oil and vinegar salad dressing based on the emulsion concepts they learned from the lava lamp activity.
11:45 AM – 12:15 PM	Working Lunch	To meet the CPE requirements, the FM team used the 30-minute lunch time to encourage teachers to brain storm ideas they have for FoodMASTER in their classroom.
12:15 – 1:05 PM	Grains	FMD reviewed grain concepts including the different types carbohydrates and grain-based proteins such as gluten. During this time, the FM team made whole-wheat and white rice for teachers to taste. Teachers were provided with the ingredients to make a Chex-mix to better understand gluten using the Nutrition Facts Label on each of the ingredients.
1:05 – 1:50 PM	Group Discussion	The FM team used this time to discuss the events of the day and receive teacher feedback regarding their satisfaction with the experience, suggestions for improvement, and their plans for implementing FM in their classrooms. This time was used as a debriefing to collect meaningful data in the form of focus groups. Teachers who did not provide consent to participate in the focus groups were provided with an alternative group discussion on the same topics to provide a collaborative environment.
1:50 – 2:00 PM	Closing	FMD thanked teachers for attending and welcomed any final questions or concerns and asked consenting teachers to fill out the satisfaction survey. Teachers signed out stating their end of day time on the sign-in sheet.

Assessing Program Implementation

The purpose of the FoodMASTER professional development workshop program evaluation was to determine the extent to which the program aligns with its intended design. Mixed methods were employed for triangulation, which allows quantitative and qualitative data to be complementary. Each can reveal unique variance which may have not been discovered by using only a single method (Jick, 1979).

Prior to evaluating the implementation of the FoodMASTER workshop, the workshop and evaluation tools were reviewed for face validity by STEM and education professionals. The goal was to provide program developers with the feedback necessary to make changes to the workshop and evaluation instruments to better serve the target audience. Evaluation tools utilized components of process evaluation to provide the necessary information to inform future program improvement. These components included fidelity, dose received (satisfaction), dose delivered (completeness), and context. The remaining two components outlined by Saunders, Evans, & Joshi (2005), reach and recruitment, were not relevant to this study due to the nature of recruitment being a countywide required teacher professional development day where teachers selected workshops to attend based on their interest and requirement to participate.

Observations, post-implementation evaluation survey, and focus groups with participants informed participant satisfaction and possible modifications for future workshops. Evaluation is a key component to determining why a program was or was not successful and is therefore essential to FoodMASTER FAN workshops during its formative years. Conducting an implementation evaluation allows for improvement in program design and adaptability to the target audience. Implementation evaluation data is the best way to ensure the intervention was delivered and received as intended by its creators (Saunders et al., 2005). This allows for a more in-depth evaluation of the program to determine how implementation could have affected outcomes (Bouffard, Taxman, & Silverman, 2003).

Educator professional development evaluation survey. The educator professional development evaluation survey (EPDES) encompassed all four components of process evaluation utilized in this study. See Table 4.2 for item alignment with process evaluation components and intended subscales. The EPDES was comprised of 30 questions with four sections including demographics (items 1-9), level of agreement (items 10-20), confidence ranking (items 21-22; 24-25), and open response (items 23; 26-30). The level of agreement and confidence ranking sections utilized five-point Likert scales. Participants were asked to indicate their level of agreement from strongly disagree to strongly agree concerning specific aspects of the workshop. Participants were then asked to rank their confidence in aspects of the workshop intended for implementation in the classroom from poor to excellent. Open-ended questions provided participants with the opportunity to present personalized feedback.

Table 4.2
Educator Professional Development Evaluation Survey Process Evaluation Alignment[1]

Question	F	DR	DD	C
Likert-Scale Level of Agreement				
10. The workshop facilitator (WF) was welcoming.	X	X		
11. The WF was knowledgeable.	X	X		
12. The WF was effective in delivering information.	X	X		
13. The workshop (WS) was what I expected.		X		
14. The WS learning objectives were met.	X		X	
15. I would recommend this WS to other educators.		X		
16. I would attend another WS hosted by the same initiative.		X		
17. I am confident I can deliver the materials introduced in today's WS.	X	X		
18. I have partnered taught with a nutrition professional before.				X
19. Good nutrition is emphasized in the work environment where I work.				X
20. One of the roles of an educator is to emphasize the importance of good nutrition practices.				X
Ranking Scores Evaluation				
21. Please rate your confidence on how to use food as a tool to teach **mathematics** <u>before</u> this professional development workshop.				X
22. Please rate your confidence on how to use food as a tool to teach **mathematics** <u>after</u> this professional development workshop.	X			
23. Why did you rate yourself with the above score (after the workshop)?	X	X		X
24. Please rate your confidence on how to use food as a tool to teach **science** <u>before</u> this professional development workshop.				X
25. Please rate your confidence on how to use food as a tool to teach **science** <u>after</u> this professional development workshop.	X			
26. Why did you rate yourself with the above score (after the workshop)?	X	X		X
Open-Ended Questions				
27. Was the workshop what you expected? Please explain.		X		
28. What are your top 3 suggestions in assisting today's hosts to better fulfill your expectations?		X		X
29. What were your top 3 favorite things about the workshop?		X		X
30. Please provide any additional thoughts regarding your workshop experience or ideas you have for the program.	X	X	X	X

[1]F, fidelity; DR, does received; DD, dose delivered; C, context; PR, participant reactions; PL, participant learning

Workshop observations. Observation of the workshop sessions provides program developers with insight into the receptiveness of participants and fidelity of implementation. An undergraduate student enrolled in the dietetics program at Northern Illinois University observed the FoodMASTER FAN workshop session on March 1, 2019 in Naperville, Illinois. The student conducted structured observations which assessed each of the four components of process evaluation used in this study. See Table 4.3 for alignment. This tool revealed implementer engagement and effectiveness, participant response and engagement, efficient use of program resources, accurate completion of activities, ability to stay on time based on the agenda, as well as barriers and facilitators to implementation.

Table 4.3
Observation Checklist Process Evaluation Alignment

Question	F	DR	DD	C
Participant Involvement				
Did the teachers effectively work with others to complete the activities?		X		
Did the activities help the teachers understand concepts?	X	X		
Did the teachers engage in the content?		X		
Effective Instruction				
Did the teacher(s) interact with presenters appropriately and responsively?	X	X		
Did the presenters(s) answer questions effectively?	X			
Did the presenters(s) display appropriate knowledge and/or preparation for lesson?	X			
Was there more than presenter implementing the workshop? If so, did the presenters work together cohesively as a team?	X			
Workshop Completion				
Was the implemented workshop as intended by the FoodMASTER Initiative?	X		X	
Were there any barriers or challenges?				X
Were all components of the workshop completed?			X	
Were proper resources utilized to sustain workshop activities? If not, were they available?	X			

Focus groups. After completion of the workshop, team members conducted semi-structured focus groups with participants. The evaluators followed a guide to determine (1) usefulness of the overall workshop; (2) participant receptivity of using food as a tool in the classroom (barriers, facilitators, and suggestions for improvement); (3) overall receptiveness to the program; and (4) teacher perceptions regarding effective teacher PD methods. To provide the opportunity to gather information from past experiences with professional development, only one component of process evaluation was addressed using this tool, dose received.

A general goal of FoodMASTER was to adequately prepare participants to successfully utilize food as a tool to teach science and mathematics concepts in the K-12 learning environment. Potential internal factors that may have impacted program theory include previous knowledge, effectiveness of the workshop, time to provide adequate education, and receptiveness of the K-12 students to the methods introduced by teachers. There were two primary external factors that may affect program theory including administrator support of using food as a tool in the classroom and resource availability for teachers.

The utilization of observations and focus groups combined provided program developers with varying insights into program fidelity in greater depth (Rossi et al., 2004); however, there are also limitations. One major limitation is that the evaluator did not collect data from the target population (K-12 students) regarding the integration methods. Workshop participants were the only individuals requested to provide details about K-12 student engagement and learning.

Data Analysis

Quantitative data was analyzed using the Statistical Package for Social Science (SPSS) 26.0. Quantitative analysis was used to analyze descriptive statistics to present demographic information and to analyze the EPDES responses. Qualitative data analysis was guided by content analysis using an inductive approach, through which responses were reviewed in an unbiased approach to obtain major content categories, key words, and themes (Kondracki, Wellman, & Amundson, 2002). All focus groups were recorded and transcribed verbatim. Analysis of focus group transcripts and open-ended survey responses began with open coding where the data was read through several times to create labels for chunks of data which then summarized this information. Once open coding was complete, the axial coding began. In this step, relationships among the open codes were identified between axial coding and open coding. Themes and subthemes were identified and recorded in a code book including a description of the axial codes (subthemes) and an example of an excerpt from the data which met the axial code requirement.

Results

This purpose of this study was to employ mixed methods to analyze qualitative and quantitative data to answer the following research questions:

4. What were participant perceptions about the PD workshop?
    a. What aspects of the PD workshop should be continued?
    b. What aspects of the PD workshop should be discontinued?
    c. How does this PD workshop compare to other experiences?
5. What components of process evaluation were met during the PD workshop?
6. How were the identified process evaluation components met during the PD workshop?
    a. Was the PD workshop implemented as intended?
    b. Were the participants satisfied with the PD workshop?
    c. Was the PD workshop completed as intended?
    d. Was the context appropriate and clear?

Workshop Evaluation Survey

The workshop evaluation survey included both quantitative and qualitative responses. Quantitative responses revealed participants were overall satisfied with the professional development workshop and its features. All participants indicated agreement with the workshop facilitators' effectiveness, the workshop itself being what was expected, and would recommend the workshop to other educators. Table 4.4 outlines all the frequencies and Table 4.5 provides the mean and standard deviations for quantitative questions.

Table 4.4

EPDES Quantitative Frequencies

Question[1]	**SD**	**D**	**SWA**	**A**	**SA**
Likert-Scale Level of Agreement					
The workshop facilitator (WF) was welcoming.				19%	81%
The WF was knowledgeable.				9.5%	90.5%
The WF was effective in delivering information.				19%	81%
The workshop (WS) was what I expected.			14.3%	28.6%	57.1%
The WS learning objectives were met.				28.6%	71.4%
I would recommend this WS to other educators.			4.8%	19%	76.2%
I am confident I can deliver the materials introduced in today's WS.			4.8%	28.6%	66.7%
I have partnered taught with a nutrition professional before.			4.8%	38.1%	57.1%
Good nutrition is emphasized in the work environment where I work.	38.1%	42.9%	4.8%	9.5%	4.8%
One of the roles of an educator is to emphasize the importance of good nutrition practices.	9.5%	4.8%	47.5%	19%	19%
Ranking Scores Evaluation[2]	**P**	**BA**	**AV**	**AA**	**E**
Please rate your confidence on how to use food as a tool to teach **mathematics** before this professional development workshop.	4.8%	9.5%	28.6%	38.1%	19%
Please rate your confidence on how to use food as a tool to teach **mathematics** after this professional development workshop.			14.3%	42.9%	42.9%
Please rate your confidence on how to use food as a tool to teach **science** before this professional development workshop[3].	4.8%	19%	19%	33.3%	19%
Please rate your confidence on how to use food as a tool to teach **science** after this professional development workshop[3].			9.5%	57.1%	28.6%

[1]SD, strongly disagree; D, disagree; SWA, somewhat agree; SA, strongly agree; A, agree
[2]P, poor; BA, below average; AV, average; AA, above average; E, excellent
[3]One participant (4.8%) indicated N/A, which was not an answer choice and therefore included in the table.

Table 4.5

EPDES Mean and Standard Deviations

	Mean	Std. Deviation
The workshop facilitator (WF) was welcoming.	4.81	.40
The WF was knowledgeable.	4.90	.30
The WF was effective in delivering information.	4.81	.40
The workshop (WS) was what I expected.	4.43	.75
The WS learning objectives were met.	4.71	.46
I would recommend this WS to other educators.	4.71	.56
I am confident I can deliver the materials introduced in today's WS.	4.62	.60
I have partnered taught with a nutrition professional before.	4.52	.60
Good nutrition is emphasized in the work environment where I work.	2.00	1.14
One of the roles of an educator is to emphasize the importance of good nutrition practices.	3.33	1.15
The workshop facilitator (WF) was welcoming.	4.48	.68
Please rate your confidence on how to use food as a tool to teach mathematics before this professional development workshop.	3.57	1.07
Please rate your confidence on how to use food as a tool to teach mathematics after this professional development workshop.	4.29	.72
Please rate your confidence on how to use food as a tool to teach science before this professional development workshop.	3.29	1.38
Please rate your confidence on how to use food as a tool to teach science after this professional development workshop.	4.00	1.10

Participants were asked to rank their confidence on how to use food as a tool to teach mathematics and science before and after the workshop. A paired samples t-test was utilized to determine if there were significant improvements pre- and post-implementation. See Table 4.6.

Table 4.6
EPDES Confidence Items t-test

Ranking Scores Evaluation	**Mean**	**SD**	**Sig**
Please rate your confidence on how to use food as a tool to teach **mathematics** before this professional development workshop.	3.57	1.08	
Please rate your confidence on how to use food as a tool to teach **mathematics** after this professional development workshop.	4.29	0.72	0.001*
Please rate your confidence on how to use food as a tool to teach **science** before this professional development workshop.	3.29	1.38	
Please rate your confidence on how to use food as a tool to teach **science** after this professional development workshop.	4.00	1.10	0.000*

*$p<0.05$ indicates significance

The first two open-ended questions invited participants to indicate why they ranked their confidence on how to use food as a tool to teach mathematics and science after the workshop. Participant responses revealed positive results highlighting the effectiveness of the workshop as well as the practical application and engaging manner of using food as a teaching tool. Some indicated the workshop helped them learn new ideas by commenting "I learned a great deal from this workshop."; "I took away some new ideas."; "…this was great because it will help me use food and nutrition to enhance what we do in science." Many participants alluded to the curriculum's ability to engage K-12 students. One participant noted, "I have always been interested in learning how to incorporate food into my classes as food appeals to most! Food holds the attention of a middle schooler." Another stated, "I think using food to educate is engaging for students and I should use it more often."

The remaining open-ended questions were in reference to the workshop as a whole and served as concluding questions where participants could provide a more personal evaluation. The first question asked participants if the workshop was what they expected and to explain their responses. Overall, most participants indicated the workshop was what was expected or better, and revealed several justifications including the WF and the hands-on activities as primary reasons. Many participants indicated the workshop was better than what was expected, “It was better as I will now incorporate more food lesson[s] to demonstrate concepts-mainly chemistry. Many good examples.” One specifically commented on the WF’s knowledge and skills by stating “Instructor’s willingness to engage and connect with audience was great. WF was/is extremely knowledgeable!”

When asked what the top three suggestions for improvement many participants stated there were no improvements which needed to be made; however, some individuals mentioned wanting access to the materials and agenda earlier, modifications to the schedule, and more examples or demonstrations and connections with the curriculum. Of the participants indicating interest in access to materials beforehand, most specifically requested the PowerPoint presentations. Participant responses pertaining to the schedule were in relation to more downtime such as a longer lunch breaks or more breaks in general. Comments regarding more demonstrations and connection to the curriculum wanted fewer personal stories and more examples or videos. One participant stated, “Maybe adding video demonstrations or videos of students doing activities.”

After being asked about the three improvements which could be made, participants were asked to describe the top three favorite aspects about the workshop. Participants overwhelmingly indicated enjoying the hands-on activities, enthusiastic WF, printed materials, group work and collaboration, and integration of food. Comments such as “Increased my desire to learn more” and “Activities that enhance math and science make it real world” highlight the positive reactions from participants regarding the workshop and curriculum. Some enjoyed being able to work with others, sharing comments such as “Working with other participants” or “Being in groups to discuss.”

The final survey item provided participants with the opportunity to provide any additional details about the workshop they felt would be beneficial. Of the 21 participants, only four provided feedback with three comments indicating further satisfaction of the workshop such as “Loved the workshop. Thank you” and “Very enjoyable.” The fourth participant stated “[I] had no idea your program was available online.”

Workshop Observation

The workshop observation consisted of a 14-item checklist where the observer answered yes or no questions while also elaborating on what was happening in relation to the question. Topics covered included participant involvement, effective instruction, and lesson completion. The observer indicated agreement with all questions and included comments such as “Teachers were very engaged” or “Teachers understood lessons and completed them as instructed with dialogue on how to adjust for their own lessons” when asked about participant involvement. Effective instruction comments indicated the presenters were knowledgeable, prepared, and adaptable such as “You could see the amount of time put into setup. When something was missing they easily adapted to make the program work.” The lesson completion responses indicated the workshop was completed as intended with a few barriers related to technology. The observer commented, “Some missed necessary items and technology difficulties” when asked about barriers or challenges.

Table 4.7
Workshop Observation Checklist Quantitative Responses

Participant Involvement	**Yes**	**No**	**N/A**
1. Did the participants effectively work with others to complete the activities?	X		
2. Did the activities help the participants understand concepts?	X		
3. Did the participants engage in the content?	X		
Effective Instruction			
4. Did the participants(s) interact with presenters appropriately and responsively?	X		
5. Did the presenters(s) answer questions effectively?	X		
6. Did the presenters(s) display appropriate knowledge and/or preparation for lesson?	X		
7. Was there more than presenter implementing the workshop?	X		
If so, did the presenters work together cohesively as a team?	X		
Lesson Completion			
8. Was the lesson workshop as intended by the FoodMASTER Initiative?	X		
9. Were there any barriers or challenges?	X		
10. Was the workshop completed in the prescribed time period?	X		
11. Were all components of the workshop completed?	X		
12. Were proper resources utilized to sustain workshop activities?	X		
If not, were they available?			X

Focus Groups

Focus group questions served to provide an open opportunity for participants to provide their perceptions regarding professional development (PD) and further feedback regarding the FoodMASTER workshop. When asked to define PD, most participants indicated the purpose was to provide additional tools or resources which could be brought back to the classroom. Many emphasized the importance of bringing new information learned to their students; “Something to bring back to the children. Something, literally, to bring back to them.” Some even mentioned PD should provide something concrete rather than theory, “…instead of all of the theory. Theory is good, but we need something that will help us in the trenches.”

After gaining an understanding of participant perceptions regarding PD, the questions switched to the FoodMASTER PD workshop. The first question addressed what participants found most effective about the FoodMASTER workshop. Participants indicated enjoying the hands-on aspects of the workshop, the applicability and relatability for their students, and the natural alignment of food to science and mathematics. One participant stated, "The ease of the activities. None of the activities were hard to do but they could be easily applied. And, you know, it's household items so it's not anything new equipment or anything you would have to buy…" Another "It's something they [K-12 students] go home and, Oh, yeah. We, you know, we used oil. We did this with… you know? So they can make those connections."

When asked what aspects of the PD workshop participants felt were least effective, most comments were positive such as "So I, I didn't feel like there was anything ineffective." Or "I actually didn't not like anything. It went very fast", but some did indicate wanting more connection with the standards stating "…there is such a push with the standards that to see the activities aligned to, hey, this is how this activity can correlate to the standard." Some suggested including more food safety components to start "So a push for food safety in the beginning saying how important it is" or "I would like to see like some of the practices being with the participants, whether it's tying your hair back 'cause we are making food products." Other comments related to needing more PD experiences at his or her school rather than going to a specific workshop. For example, one participant stated, "…our school seems to have trouble finding professional development to come into our school and we're supposed to have, like, an afternoon of it."

The final set of questions asked participants about effective and ineffective previous PD experiences. Most comments related to how large lecture-based workshops are boring and ineffective. Comments such as “I think that ineffective is when you're sitting there and you're in an, in a location you're listening for six hours and it's more of a formal, a boring lecture as opposed to hands-on.” Effective experiences were reported to be timely, have hands-on, engaging, practical content or have engaging and interesting presenters. Participants seemed very pleased with PD experiences where the schedule was similar to a school day and not all day long; “So to hear that you can be there from 9:00 to 2:00… I mean, you just come with a whole different frame of mind.” Others indicated boring or monotone facilitators were big issues even when the subject matter was interesting. One participant commented on a previous experience stating “…he's very monotone. It was just everything was written down. He read right out the paper.” When it came to the most effective, hands-on was the most common response with comments such as “The ones where I was most engaged, and the ones where I was physically hands-on doing it versus listening to go through it where I got, where the talk was minimal and me doing was maximum” or “Ha-having more time on task and, and, you know, talking with other, like, professionals about situations, and experiences, and how, you know, you've been able to apply re-real-time what you're doing. And, and using it in the classroom. And then going in and using it right away.”

Discussion and Implications

This mixed methods study employed a process evaluation of the FoodMASTER Initiative’s Food and Nutrition (FAN) teacher professional development (PD) workshop by observing and collecting valuable information from participating teachers directly after attending the FAN PD workshop. Although the primary function was to conduct a process evaluation, select questions on the EPDSS also measured immediate program impact to provide a more comprehensive evaluation (Rossi et al., 2004). This discussion summarizes the findings and implications based on participant feedback and engagement in the FAN PD workshop.

The goal of process evaluation is to discover quality assurance information for program developers which can ensure participants are receiving the intended information. Problems with facilities or personnel including lack of motivation, expertise, and training could lead to issues with quality assurance and can be identified by employing a thorough process evaluation. Process evaluation is considered the most common type of program evaluation and can be employed alone or combined with impact evaluation to provide a more robust picture (Rossi et al., 2004). The FoodMASTER FAN PD workshop used observations, focus groups, and a post-implementation evaluation survey to collect process and impact evaluation data to ensure program effectiveness.

The evaluation survey, the first step in developing a generalizable valid and reliable PD evaluation survey, was analyzed using a principle components analysis to determine feasibility and first steps toward a final instrument. Based on the preliminary findings in this study, the redesign of the evaluation survey to focus on satisfaction using Kirkpatrick's four-level model (1994) of evaluation was employed to provide an effective framework for developing distinct subscales to help measure a workshop's impact on participant's reactions, attitudes or efficacy, and their intended classroom practices (Gorozidis, & Papaionnou, 2014; Ingvarson et al., 2005).

Participant perceptions are an invaluable asset when determining program effectiveness. Overall, FoodMASTER FAN PD workshop participants reported a positive experience and even reported gains in their confidence using food as a tool to teach mathematics and science when asked to compare confidence before and after the workshop. While this self-reported efficacy directly after attending the workshop does not provide implementation teacher efficacy, including active learning experiences in teacher PD has been shown to increase self-efficacy in the classroom (Desimone, 2009). Engaging teachers through real-life, application-based activities can provide valuable active learning experiences (Nathan, Atwood, Prevost, Phelps & Tran, 2011; Scott, 2012; Hayden et al., 2011). Teachers can experience what their students will be learning leading to improved self-efficacy (Nathan et al., 2011; Hayden et al., 2011).

When asked if they would recommend the workshop to others, approximately 76 percent of participants indicated strong agreement. Areas which participants highlighted as benefits of the workshop and possibly why teachers indicated they would recommend the workshop to others, were that the workshop was hands-on, engaging, coherent, and collaborative, all of which are aspects identified as crucial components of effective teacher PD experiences (Desimone, 2009). The primary missing component, duration, can lead to less impact on teacher efficacy and attitudes (Munson, Moskal, Harriger, Lauriski-Karriker, & Heersink, 2011); however, by adding an online community for teachers to continue participating in after attending the workshop duration can be fulfilled (Hayden et al., 2011). Features to consider including would be an online chat community where experts, coaches, master teachers, and peers are available to answer questions or to talk about what went well and did not go well after implementing a FoodMASTER activity (Scott, 2012). Participant suggestions for improvement were primarily related to providing additional supporting materials and gaining access to the materials before attending the workshop, which could both be elements to include if an online component of the workshop were created to provide continuous access to FoodMASTER resources.

Despite the overwhelmingly positive feeling from workshop participants, FoodMASTER can still make improvements on future programming related to duration and as a result can improve content by providing an outlet for collaboration and ease of access to resources in the same location. Once these elements are addressed, the FoodMASTER Initiative can then begin to execute its plans to develop and implement a Reach to Teach program which trains Registered Dietitian Nutritionists (RDN) to provide similar teacher PD experiences across the country. This effort will allow FoodMASTER to reach considerably more teachers each year. By utilizing the results of this study, FoodMASTER can provide future participants with a more satisfying experience ultimately resulting in greater engagement and implementation in the classroom.

Implications

Similar programs can use the findings from this study to implement comparable activities and evaluation methods. Considering the overall participant satisfaction with the format of the workshops, and the valuable feedback which can be easily used to make meaningful modifications to programming, PD developers should implement similar efforts to ensure satisfactory PD offerings. If teachers are satisfied with their PD experience, they are more likely to implement its activities in their classrooms and achieve increased UM K-12 student engagement in STEM through every day concepts (Frechtling et al., 1995; Guskey, 2000). Similar PD developers should also take into account duration, the limiting factor of the FoodMASTER teacher PD workshop.

The most effective K-12 teacher PD experiences are ongoing and employ multiple methods of instruction with collaboration as a key area of focus (Scott, 2012); however, PD experiences aimed at preparing teachers to implement new curricula or activities are typically shorter in length and do not include much collaboration (Munson et al., 2011). Building an online collaborative network where teachers can utilize chats, wikis, blogs, forums, and journals to discuss teaching experiences after the professional development workshop can lead to improved fidelity (Hayden et al., 2011). By supporting professional dialog throughout the school year, online networks can also lead to improved teacher efficacy. Increased teacher efficacy can improve K-12 student engagement, persistence, knowledge, and skills in STEM which can increase interest in pursuing STEM career fields (Povtin, & Hasni, 2014; Ingvarson et al., 2005).

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CHAPTER FIVE: Summary and Implications for Policy, Practice, and Future Research

Summary

The collection of essays in this dissertation are aimed at discovering innovative approaches to impact learning environments in the K-12 classroom by examining concepts related to teacher professional development (PD) curricular quality using both quantitative and qualitative methods. The three essays combined provides scientist and clinician PD K-12 teacher developers with necessary information on what culminates in teacher PD curricular quality. While these three studies are distinctly different in study aims and scope, the information derived from these studies provides science educators with research-based education practices in offering and evaluating quality teacher PD. The following research questions directed the process for this collection of essays:

1. What K-12 teacher PD and teaching techniques and strategies are being used to engage underrepresented minority (UM) youth in STEM?
2. What is the factor structure and reliability of a researcher-developed educator professional development satisfaction survey?
3. What are the quality indicators of a hands-on, application-based STEM food and nutrition teacher PD workshop which should be maintained and what should be reconsidered in future offerings?

The studies presented in this dissertation provide important information and resources for STEM teacher PD developers for engaging UM youth in K-12 STEM to better support the STEM career pipeline. These studies made evident that both UM K-12 students and teachers prefer engaging instructional methods; however, some teachers entertain misconceptions about UM K-12 student abilities to be successful in STEM which contributes to the already racial and ethnic imbalance in STEM careers. By creating application-based hands-on teacher PD experiences aimed at preparing teachers to implement similar practices in the classroom considered more engaging by UM K-12 students, STEM PD developers can begin to combat the unbalanced STEM workforce.

The integrative review of literature presented in Chapter Two highlighted how the K-12 education system engages minority K-12 students in learning STEM and pursuing its careers opportunities. By promoting STEM to K-12 students before graduating from high school, the number of minority post-secondary students pursuing STEM careers could be greatly increased. Creating a fun environment for K-12 students to learn science and mathematics can increase interest and persistence in STEM careers. Teachers, however, must be adequately prepared to engage the ever-changing diverse K-12 student body. Chapter Three presented a valid and reliable educator PD satisfaction survey which can utilized by STEM PD programs to ensure participants are satisfied with the PD programming, which can lead to increased classroom implementation and implementer fidelity. In Chapter Four, a STEM food and nutrition teacher PD program was evaluated using focus groups, observation, and a satisfaction survey to determine participant satisfaction and inform future improvements to better engage participants and lead to higher classroom implementation rates. In each of these studies, the need for engaging STEM teacher PD experiences is a topic area of importance for engaging UM youth in STEM.

Chapter Two, an integrative literature review, explored teacher PD and concepts which promote careers in health sciences for underrepresented minority youth. The study utilized Whittemore and Knafl’s (2005) methodology strategies for conducting an integrative review and revealed crucial information for STEM PD developers. UM K-12 students who possess a greater understanding of applicability display more interest and engagement resulting in increased performance and persistence in STEM (Hulleman & Harackiewicz, 2009). Focusing on preparing teachers to better understand the needs of UM youth using curricula based in biomedical science, which is innately hands-on and application-based, can serve as a pipeline from the K-12 education system to STEM undergraduate programs (Perry, Link, Boetler, & Leukefeld, 2012). Creating and preparing teachers to implement these efforts could provide UM youth with the tools needed to pursue the many career opportunities in health and biomedical sciences which are in demand of a more diverse workforce (Li, Ernest & Williams, 2015; (Nathan, Atwood, Prevost, Phelps & Tran, 2011; Schmidt, Kafkas, Maier, Shumow, & Kacker-Cam, 2019; Perry, Link, Boelter, Leukefeld, 2012; Fleischer, Wemhoff, Obrien, Ural, & Alaways, 2010).

Chapter Three findings prompted minor revisions to the proposed educator PD satisfaction survey (EPDSS). The proposed EPDSS included three factors: reactions, motivation, and program characteristics; however, the exploratory factor analysis indicated only two factors were analyzed in this survey, reactions and motivation. After running Cronbach's alphas if items were deleted, deleting item 15 revealed reliability would increase from 0.907 to 0.925. Considering the low factor analysis values and increased reliability, item number 15 was deleted from the final survey. The final EPDSS was comprised of 20 items aimed at assessing satisfaction which can provide valuable information regarding participant reactions to the programming and motivation to implement knowledge and skills learned in the classroom as a result of the PD experience.

Chapter Four findings revealed teacher perceptions regarding the Food, Math, and Science Teaching Enhancement Resource (FoodMASTER) food and nutrition STEM professional development workshop. FoodMASTER curricula utilizes hands-on, application-based methods in the classroom to engage K-12 students in learning by using food as a tool to teach mathematics and science. Overall, teachers enjoyed the hands-on aspects of the workshop, but would have preferred more communication before attending the workshop to better prepare to understand concepts introduced during the workshop. Teachers also indicated motivation to implement knowledge and skills learned in the workshop as well as recommend the program to other teachers.

Implications for Policy, Practice, and Future Research

Policy

Teacher PD experiences provide an ideal opportunity to deliver continuing education opportunities on how to handle delicate situations with UM groups. Food insecurity for example, is an issue many UM K-12 students face today which can negatively impact student achievement. UM groups are more likely to participate in programs such as the National School Lunch Program (NSLP) aimed at combating hunger in schools. Government programs such as the NSLP have been enacted to prevent K-12 students from dealing with the negative impacts of hunger. The NSLP enacted in 1946 by President Harry Truman was initially aimed at addressing childhood malnutrition which resulted in medical conditions preventing individuals from entering the military during World War II; however, its history truly began during the depression in the 1930's when the government realized federal assistance for school nutrition was essential because K-12 students were unable to pay for lunches and could not concentrate in school without proper food and nutrition (Gunderson, 1972). In its first year, the program served just under 350 thousand K-12 students which has significantly risen to more than 31 million K-12 students currently participating in the NSLP (Gunderson, 1972; Gunderson, Kreider, & Pepper, 2011).

According the most recent National Health and Nutrition Examination Survey (NHANES) NSLP demographic data for K-12 students, 69.5 percent of Non-Hispanic Black students, 64.2 of Hispanic students, and 47.6 percent of other students were receiving free lunches as compared to 24.9 percent of the Non-Hispanic White population, indicating a significant gap in potential food insecurity issues between UM K-12 students and their peers (Newman & Ralston, 2006). Using PD experiences to introduce new and engaging methods or content can greatly improve K-12 student engagement; however, these opportunities can also be utilized to remind teachers about issues such as food insecurity, UM K-12 students may experience which could improve UM K-12 student engagement in school, especially the more challenging courses in STEM. Considering the current misconceptions teachers have about UM K-12 students being successful in STEM-related courses and careers, helping teachers understand the barriers UM face and utilizing more application-based, hands-on methods in the classroom to support learning (Nathan et al., 2011; Schmidt et al., 2019).

Educational policy leaders should take into consideration UM youth needs from teachers. While teachers are required to attend PD experiences, there are no policies in place outlining the type of continuing education teachers should attend and demonstrate competence. By requiring teachers to attend not only general cultural competency training, but also training aimed at preparing teachers to implement applicable activities that can be related to everyday life, teachers can better engage UM K-12 students in STEM. These experiences have been found to be the most influential factor on career trajectories (Fleischer et al., 2010). This method allows teachers to apply meaning and value to learning rather than learning for the only purpose of learning required content (Hulleman & Harackiewicz, 2009).

Practice

Potentially the most impactful component of this dissertation is the effect on practice these essays can have on teacher PD quality. Understanding what teachers need from PD experiences to transfer knowledge gained during the experience is essential to impacting K-12 student attainment, especially for underrepresented minority (UM) groups. With the anticipated increase in demand for STEM careers and the alarmingly low percentage of UM groups in these careers, finding effective methods for preparing teachers to better engage these K-12 students is essential to diversify the workforce, especially in health professions and biomedical sciences. Considering demographic trends are indicating 50 percent of the population will be what is now considered minority by 2050, it is essential for biomedical and health professions to increase their efforts to recruit and retain minority groups (Smedley, Colburn, & Evans, 2001). A more diverse health professional workforce will ultimately increase cultural competency, provide greater access for minority patients, and increase health care administrator knowledge about diverse populations resulting in better responsiveness to their needs (Beach et al., 2005).

The most effective general teacher PD experiences are ongoing and employ multiple methods of instruction with collaboration as a key area of focus (Scott, 2012); however, PD experiences aimed at preparing teachers to implement new curricula or activities are typically shorter in length and do not include much collaboration (Munson, Moskal, Harriger, Lauriski-Karriker, & Heersink, 2011). Building an online collaborative network where teachers can utilize chats, wikis, blogs, forums, and journals to discuss teaching experiences after the professional development workshop can lead to improved fidelity (Hayden, Ouyang, Scinski, Olszewski &

Bielefeldt, 2011). By supporting professional dialog throughout the school year, online networks can also lead to improved teacher efficacy. Increased teacher efficacy can improve K-12 student engagement, persistence, knowledge, and skills in STEM which can increase interest in pursuing STEM career fields (Povtin, & Hasni, 2014; Ingvarson et al., 2005).

Future Research

The results of this collection of essays provide a foundation for developing, implementing, and evaluating STEM teacher PD programming. Future research should focus on how to engage more teachers in similar programming to reach a larger number of teachers. The FoodMASTER Initiative plans to utilize the findings from these essays to develop a Reach to Teach program which trains Registered Dietitian Nutritionists (RDN) to provide similar teacher PD experiences across the country. By training more experts to prepare teachers to implement food-based curricula in the classroom, more teachers can be reached. Currently FoodMASTER can only host one to two workshops (20-30 teachers per workshop) each year with one RDN; however, after training RDN's across the country the number of teachers reached can be greatly increased to hundreds.

Another area of interest for future research is to focus on reaching educators in UM communities, specifically the American Indian population in the Midwest. I plan to focus my future research on preparing community educators to implement engaging STEM activities in North and South Dakota. I aim to develop PD experiences for community educators to utilize food as a tool to implement hands-on application-based methods in the American Indian communities after school hours. It is my goal to serve underrepresented populations with the utmost integrity and respect. The American Indian population is a large part of the Dakota community and history, which to me means efforts must focus on serving this community to the best of our ability. Mortality rates among the American Indians are significantly higher than the average American for diseases including chronic liver disease and cirrhosis and diabetes mellitus (Indian Health Service, 2019). Collaborating with community educators to provide engaging STEM curricula will go a long way in reaching the American Indian community, and in turn increase K-12 student pursuit of STEM careers to better serve the population and aid in reducing health disparities.

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APPENDICES

Appendix A. Educator Professional Development Satisfaction Survey Analyzed Items

Professional Development Satisfaction Survey

PART I Background Information

Part II Level of Agreement
Please indicate your level of agreement with the following statements on a scale from 1-5: Strongly Disagree (1), Disagree (2), Neither Agree or Disagree (3), Agree (4), Strongly Agree (5)

The instructor(s) was/were:
- organized
- prepared
- responsive to questions and concerns
- effective in delivering information
- able to convey ideas for classroom implementation

The workshop:
- met my expectations
- objectives were met
- was timely
- was relevant to my practice
- resources will help me implement the content in my classroom
- helped me gain new knowledge I will use in the classroom
- helped me gain new skills I will use in the classroom

PART III Perceived Value and Quality
Please rate the following on a scale of 1-5: Poor (1), Below Average (2), Average (3), Above Average (4), Excellent (5)

Instructor and workshop:
- The instructor(s) background foundation knowledge
- The instructors(s) curricular material knowledge
- Your impression of the overall quality of the course materials

Your confidence in:
- your knowledge regarding the information introduced in today’s workshop at the end of the day
- your ability to perform the skills introduced in today’s workshop at the end of the day

PART IV: Open Response

Appendix B. Educator Professional Development Satisfaction Online Survey

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Start of Block: Default Question Block

Q1 **Welcome to the 2019 K-12 Summer Institute (SI).** Please take a moment to complete the SI professional development (PD) course evaluation. We greatly appreciate your feedback. You will not be identified in reports as an individual and all data will be aggregated when reported. Completion of this form indicates informed consent.
I identify:

- ○ Male (1)
- ○ Female (2)
- ○ Other preferred gender identification: (4) ____

Q2 I identify:

- ○ African American (1)
- ○ Asian (2)
- ○ Caucasian (3)
- ○ American Indian/Alaska Native (4)
- ○ More than One race (5)
- ○ Other (6) ____

Page Break

Q3 I identify:

○ Hispanic or Latino (1)

○ Not Hispanic or Latino (2)

Q4 I am

○ 18-29 (1)

○ 30-39 (2)

○ 40-49 (3)

○ 50-59 (4)

○ 60-69 (5)

○ 70+ (6)

Page Break

Q5 I am a

○ Teacher (1)

○ Community Educator (2)

○ Student (3)

○ Other (4) ____

Q6 Primary employer:

- ○ Public school (1)
- ○ Private School (4)
- ○ Youth organization (5)
- ○ Museum (6)
- ○ Other (please indicate): (7) ____

Page Break

Q7 Location of employment:

- ○ Rural (1)
- ○ Urban (2)
- ○ Suburban (3)
- ○ Other (4) ____

Q8 Grade(s) taught (check all that apply):

- ☐ Pre-K (1)
- ☐ 1st (2)
- ☐ 2nd (3)
- ☐ 3rd (4)
- ☐ 4th (5)
- ☐ 5th (6)
- ☐ 6th (7)
- ☐ 7th (8)
- ☐ 8th (9)
- ☐ 9th (10)
- ☐ 10th (11)
- ☐ 11th (12)
- ☐ 12th (13)
- ☐ Other (14) ____

Page Break

Q9
How long have you been a practicing educator?

- ○ 1-3 years (1)
- ○ 4-7 years (4)
- ○ 8-10 years (5)
- ○ 10-15 years (6)
- ○ 15 + years (7)
- ○ N/A (8)

Q10 I have completed

- ○ Associate Degree (1)
- ○ Bachelor's degree (4)
- ○ Some graduate courses (5)
- ○ Master's degree (6)
- ○ Doctoral degree (7)
- ○ Other (8) ____

Page Break

Q11 Please indicate the State in which you practice:

▼ Alabama - AL (4) ... Wyoming - WY (55)

Page Break

Q12
Please select the correct day and evaluate only one training session at a time.   Thank you.

○ Monday July 22th (1)

○ Tuesday July 23th (2)

○ Wednesday July 24th (6)

○ Thursday July 25th (7)

Skip To: Q13 If Please select the correct day and evaluate only one training session at a time.   Thank you. = Monday July 22th

Skip To: Q14 If Please select the correct day and evaluate only one training session at a time.   Thank you. = Tuesday July 23th

Skip To: Q15 If Please select the correct day and evaluate only one training session at a time.   Thank you. = Wednesday July 24th

Skip To: Q16 If Please select the correct day and evaluate only one training session at a time.   Thank you. = Thursday July 25th

Q13
SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22

▼ Junior Master Gardener- Gardening fun for young students! (12) ... NEW: DNA Barcoding: Citizen Science in Action (39)

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = Junior Master Gardener- Gardening fun for young students!

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = DNA is Elementary!

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = Teaching Big Science Concepts with Tiny Protozoa

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = ELL Strategies for the Science Classroom - *Engineering Strand*

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = NEW: Mosquitoes and Me: A Curiosity-Based Ambitious Science Approach To Teaching With Insects - part 1

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = NEW: CerebroEdu: Neuroscience for Latinx Youth

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = The Archeology of Texas

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = Genetics in the past, present and future: From Woolly Mammoths to genetic engineering in outerspace - *Engineering Strand*

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING MON. JULY 22 = NEW: DNA Barcoding: Citizen Science in Action

Q14 SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23

▼ Playful Learning : Engaging Strategies for the Early Childhood Learner (32) ... NEW: DNA Barcoding: Citizen Science in Action (49)

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = Playful Learning : Engaging Strategies for the Early Childhood Learner

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = NEW: Design Thinking in the Science Classroom

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = NEW: Literacy Strategies in the Science Classroom

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = Junior Master Gardener - Integration of Science, Math, and Literature in the Garden!

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = NEW: Mosquitoes and Me: A Curiosity-Based Ambitious Science Approach To Teaching With Insects - part 2

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = Teaching Big Science Concepts with Tiny Protozoa

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = Explore Water While Raising Your Water IQ

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = Soil Metagenomics: The Unseen World Beneath Our Feet

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING TUES. JULY 23 = NEW: DNA Barcoding: Citizen Science in Action

Q15 SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24

▼ NEW: Design Thinking in the Science Classroom (37) ... NEW: It Takes a Cross-Disciplinary Village: Integrating Type 2 Diabetes Concepts into Science and Health Classes - *Engineering Strand (46)

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = NEW: Design Thinking in the Science Classroom

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = The Journey of Water and You

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = Winds-ups: rubber-band-powered cars and helicopters - *Engineering Strand*

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = NEW: It's Only Natural!

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = NEW: STEM Challenges and Engineering in the Elementary and Middle School Classroom - *Engineering Strand*

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = Electric Masks, Pop-ups and Puppets - *Engineering Strand*

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = Pop-up Cards and Books - *Engineering Strand*

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = NEW: What's in Your Water?

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = The Great Diseases: Teaching Cancer Biology

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING WEDS. JULY 24 = NEW: It Takes a Cross-Disciplinary Village: Integrating Type 2 Diabetes Concepts into Science and Health Classes - *Engineering Strand*

Q16 SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25

▼ Invent-a-Wheel: Make a gravity-powered car - *Engineering Strand (13) ... The High School Research Initiative: Open-Inquiry and University Collaborative Research (No tests!) (47)

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = Invent-a-Wheel: Make a gravity-powered car - *Engineering Strand*

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = NEW: Color Mixing with Light-Emitting Diodes (LEDs) - *Engineering Strand*

*Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = NEW: MechAnimations: Mechanisms that Animate Stories or Ideas - *Engineering Strand*

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = The Journey of Water and You

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = Engaging students with next generation game-based learning environments

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = NEW: Teaching Science Through Citizen Science and Big Data

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = Teaching DNA, Proteins, and Protein Synthesis with the MIT Edgerton Center Hands-on Models and Curriculum

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = The Archeology of Texas

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = NEW: The Great Diseases: Teaching Scientific Skills Through Case Studies

Skip To: Q17 If SELECT THE WORKSHOP THAT YOU ARE EVALUATING THURS. JULY 25 = The High School Research Initiative: Open-Inquiry and University Collaborative Research (No tests!)

Q17. Level of Agreement. Please indicate your level of agreement with the following statements.

The instructor(s) was/were:

	Strongly Agree (1)	Agree (2)	Neither Agree nor Disagree (3)	Disagree (4)	Strongly Disagree (5)
organized. (2)	○	○	○	○	○
prepared. (3)	○	○	○	○	○
responsive to questions. (4)	○	○	○	○	○
effective in delivering information. (5)	○	○	○	○	○
able to convey ideas for classroom implementation. (6)	○	○	○	○	○

Page Break

Q18. Level of Agreement. Please indicate your level of agreement with the following statements. The workshop:

	Strongly Agree (8)	Agree (9)	Neither Agree nor Disagree (11)	Disagree (12)	Strongly Disagree (14)
met my expectations. (1)	○	○	○	○	○
objectives were met. (13)	○	○	○	○	○
was timely. (14)	○	○	○	○	○
was relevant to my practice. (15)	○	○	○	○	○
resources will help me implement the content in my classroom. (16)	○	○	○	○	○
helped me gain knowledge I will use in the classroom. (17)	○	○	○	○	○
helped me gain skills I will use in the classroom. (18)	○	○	○	○	○

Page Break

Q19 Perceived Value and Quality. Please rate the following statement below.

	Excellent (1)	Above Average (2)	Average (3)	Below Average (4)	Poor (5)
The instructor(s) foundational knowledge of the subject matter. (1)	○	○	○	○	○
The instructor(s) knowledge of the curricular materials. (7)	○	○	○	○	○
Your impression of the overall quality of the course materials. (8)	○	○	○	○	○
Confidence in your knowledge regarding the information introduced in today's workshop at the end of the day. (9)	○	○	○	○	○
Confidence in your ability to perform the skills introduced in today's workshop at the end of the day. (10)	○	○	○	○	○

Page Break

Q20 What was the most significant aspect of this WS that you will apply in your classroom? Why?

____

____

____

____

____

Q21 What component(s) of this workshop will you apply in your classroom? Why?

____

____

____

____

____

Q22 What were the strengths of this workshop?

____

____

____

____

____

Page Break

Q23 Please provide any additional thoughts regarding your workshop experience or ideas you have for the program.

____

____

____

Q24 Please submit your feedback now. Upon submitting your feedback you will be directed to the beginning of the evaluation so that you may evaluate the next workshop. If you are finished evaluating the workshop(s) please leave the browser open for the next participant. On behalf of the Community Outreach and Education Program Team, we would like to thank you for all that you do in the classroom.

End of Block: Default Question Block

Appendix C. FoodMASTER Educator Professional Development Evaluation

Workshop # ____

Champion(s): __________________________ Location: _____________________________ Date: _____________

Participant #____

Educator Professional Development (PD) Evaluation
FoodMASTER

Thank you, educators, for your participation in FoodMASTER PD! Please take a moment to complete the evaluation form. Our goal is to provide high quality educator PD and we appreciate your feedback. You will not be identified in any reports as an individual and data will be presented in summary form only. Completion of this form will indicate your informed consent.

Demographics

1. **I identify (check one):** ☐ Male ☐ Female
2. **I identify (check one):** ☐ African American ☐ Asian ☐ Caucasian ☐ Hispanic ☐ More than one race ☐ Other: ____
3. **I am (check one):** ☐ 18-29 ☐ 30-39 ☐ 40-49 ☐ 50-59 ☐ 60-69 ☐ 70+
3. **I am a (check one):** ☐ Teacher ☐ Community Educator ☐ Student ☐ Other (please indicate): ____
4. **Primary employer (check one):** ☐ Public school ☐ Private School ☐ Youth organization ☐ Museum ☐ Other (please indicate): __________________________
5. **Location of employment (check one):** ☐ Rural (population<2,500) ☐ Urban ☐ Suburban ☐ Other (please indicate): ____
6. **Grade(s) taught (check all that apply):** ☐ PreK ☐ K ☐ 1st ☐ 2nd ☐ 3rd ☐ 4th ☐ 5th ☐ 6th ☐ 7th ☐ 8th ☐ 9th ☐ 10th ☐ 11th ☐ 12th ☐ Other (please indicate): __________________
7. **How long have you been a practicing educator? (check one):** ☐ 1-3 years ☐ 4-7 years ☐ 8-10 years ☐ 10-15 years ☐ 15 + years ☐ N/A
8. **I have completed (check one):** ☐ Associate Degree ☐ Bachelor's degree ☐ Some graduate courses ☐ Master's degree ☐ Doctoral degree ☐ Other (please indicate): __________________________________
9. **Please indicate the State in which you practice:** ___________________________

Please circle your level of agreement with each of the following statements.

	Strongly Agree	Agree	Somewhat Agree	Disagree	Strongly Disagree
10. The workshop facilitator (WF) was welcoming.	SA	A	SWA	D	SD
11. The WF was knowledgeable.	SA	A	SWA	D	SD
12. The WF was effective in delivering information.	SA	A	SWA	D	SD
13. The workshop (WS) was what I expected.	SA	A	SWA	D	SD

14. The WS learning objectives were met.	**SA**	**A**	**SWA**	**D**	**SD**
15. I would recommend this WS to other educators.	**SA**	**A**	**SWA**	**D**	**SD**
16. I would attend another WS hosted by the same initiative.	**SA**	**A**	**SWA**	**D**	**SD**
17. I am confident I can deliver materials introduced in today's WS.	**SA**	**A**	**SWA**	**D**	**SD**
18. I have partnered teaching with a nutrition professional before.	**SA**	**A**	**SWA**	**D**	**SD**
19. Good nutrition is emphasized in the learning environment where I work.	**SA**	**A**	**SWA**	**D**	**SD**
20. One of the roles of an educator is to emphasize the importance good nutrition practices.	**SA**	**A**	**SWA**	**D**	**SD**

Please circle your rating of each of the following statements.
5-Excellent, 4-Above Average, 3-Average, 2-Below Average, 1-Poor

	Excellent	Above Average	Average	Below Average	Poor
21. Please rate your confidence on how to use food as a tool to teach *mathematics before* this professional development workshop.	**5**	**4**	**3**	**2**	**1**
22. Please rate your confidence on how to use food as a tool to teach *mathematics after* this professional development workshop.	**5**	**4**	**3**	**2**	**1**

23. Why did you rate yourself with the above score (after workshop)?

24. Please rate your confidence on how to use food as a tool to teach *science before* this professional development workshop.	**5**	**4**	**3**	**2**	**1**
25. Please rate your confidence on how to use food as a tool to teach *science after* this professional development workshop.	**5**	**4**	**3**	**2**	**1**

26. Why did you rate yourself with the above score (after workshop)?

Thank you for your honest feedback! **Please print clearly.**
27. Was the workshop what you expected? Please explain.

28. What are your top 3 suggestions in assisting today's hosts to better fulfill your expectations?

1)

2)

3)

29. What were you top 3 favorite things about the workshop?

1)

2)

3)

30. Please provide any additional thoughts regarding your workshop experience or ideas you have for the program.

Appendix D. Focus Group Protocol

OPENING:

Hello, *Everyone, and thank you for agreeing to participate in our FoodMASTER workshop focus group to talk about your experiences today.* Before we get started, I want to go through each section of the consent form and explain what it means. It's long, so bear with me.

At the end, I will ask you to give verbal consent to participate in this focus group. Is it alright if I begin?

[If anyone says no, ask if they have any concerns that need to be addressed that prevents them from moving forward.]

A. <u>General Information about research studies:</u>

This is a research study, and your participation in this study is voluntary. You have the right to be a part of this study, to choose not to participate or to stop participating at any time without penalty. The purpose of research study is to gain a better understanding of a certain topic or issue. You are not guaranteed any personal benefits from being in a study. Research studies also may pose risks to those that participate. In this consent form you will find specific details about the research in which you are being asked to participate. If you do not understand something in this form, it is your right to ask me for clarification or more information. A copy of this consent form has been provided to you. If at any time you have questions about your participation, do not hesitate to contact Melani Duffrin or myself.

B. <u>Purpose of this study:</u>

The purpose of this study is to look at the impact of FoodMASTER's professional development workshop on the implementation of the FoodMASTER FAN Cards in your classroom. I will ask you questions about your experiences implementing part(s) of the curriculum along with general questions about professional development workshops and specifically, the FoodMASTER professional development workshop you attended. If you do not feel comfortable answering a question, please let me know, and I will continue to the next question.

C. <u>What will happen if you take part in the study?</u>

If you agree to participate in this study, we will talk between 20 to 30 minutes, depending on how much you want to share with me. I will take notes and record the focus group session.

D. <u>Risks</u>

We will ask you questions related to your experiences with the FoodMASTER professional development workshop. This process may make you uncomfortable as you will be asked to share personal experiences and feelings with me. You are free to not answer any questions that you do not wish to answer.

E. <u>Benefits</u>

We plan to use the project findings to develop a qualitative study to assess the effectiveness of FoodMASTER's professional development workshop. We hope to use this information to improve the quality of professional development for future teachers.

F. <u>Confidentiality</u>

The information in the study documents will be kept confidential. Data will be stored electronically on password protected computers to which only the research team has access. Hard copies of focus group transcripts will be kept in a secure and locked location on NIU's campus. Within ten years after the conclusion of the study, the digital recordings will be erased. If we use quotes when presenting the findings, your name will not be linked to the response, and we will not use quotes that could identify you. We would ask that you not share the questions we ask in this interview with anyone else to avoid contaminating our sample.

Additionally, I would like to ask you to provide a pseudonym for yourself. That is, I would like you to make up a name for me to call you. What name would you like me to call you?

Ok, we only have a few paragraphs left. I would like to use an audio recorder during the discussion so that I can refer back to the discussion when I write my research report. Do you mind if I record this interview session?

a . (NO) Thank you!
b . (YES) OK. I'm afraid we have to audio record the focus group. Because of that, you will not be able to participate in focus group today. Thank you for your time.

[PRESS BUTTON HERE]

It's on. You are now being recorded.

G. <u>Questions</u>

If you have any questions about this project, please contact Melani Duffrin. If you have questions about your rights and you would rather contact NIU, please contact the Office of Research Integrity and Compliance at Northern Illinois University. Both of their contacts are on the consent form you have in front of you.

H. <u>Consent to Participate</u>

Do you have any questions?
If you agree to participate, would you please read the statement at the bottom of the consent form, giving your consent to participate today?

Participant reads:
"I have read and understand the above information. I have received a copy of this form. I give verbal consent to participate in this study with the understanding that I may choose not to participate or to stop participating at any time without penalty or loss of benefits to which I am otherwise entitled."

[Indicate on your copy of the consent form that they agreed by writing their name in the participant line and signing your name on the investigator line and dating the document.

FOCUS GROUP QUESTIONS:

Okay! Let's go ahead and get started. I'm going to start off with a simple question just to get our conversation going. Then, I'll ask you a few more questions.

Remember, I'm interested in hearing about what you've experienced, so please give me a lot of examples and tell stories. When you tell stories, please do not refer to people in your stories by their real name. You can make up a pseudonym for that person or refer to them by their relationship to you. Remember, this is all about what you think. No information is too simple or too complex.

Do you have any questions?

Alright. The first question is an icebreaker to start our discussion.

A. DESCRIBE:

1. What is your definition of professional development?

OPTIONAL PROBES

Can you explain this more?
Can you give an example?
Can you think of anything else?
I'm looking for where you might have learned this information. Do you remember where you might have learned about that?

[***Optional Transition*:** Now that you've described to me your definition of professional development, let's talk more specifically about the FoodMASTER workshop you attended.

B. EFFECTIVENESS:

1. What components of the FoodMASTER professional development workshop did you find most effective?

2. What components did you find most ineffective?

3. Do you feel the methods used to implement the workshop helped improve your ability to use food as a tool to teach mathematics and or science concepts in your classroom? Please explain.

OPTIONAL PROBES

Can you explain this more?
Can you give an example?

Can you think of anything else?
I'm looking for where you might have learned this information. Do you remember where you might have learned about that?

[***Optional Transition*:** Thank you. You've given me a lot of good information.]
[***Optional Transition***: Ok, so we just talked more specifically about FoodMASTER professional development. Now let's talk about other professional development experiences you may have had.]

C. PAST PROFESSIONAL DEVELOPMENT EXPERIENCES:

1. Please describe your most effective teacher professional development experience.
   - What aspects made the experience effective?

2. Please describe a professional development experience you found ineffective.
   - What aspects made the experience ineffective?

OPTIONAL PROBES
Can you explain this more?
Can you give an example?
Can you think of anything else?
I'm looking for where you might have learned this information. Do you remember where you might have learned about that?

Were there any aspects you excluded?

3. If you had the opportunity to attend your ideal professional development workshop, what would it look like?
   - Resources, activities, follow-up after the workshop?

REQUIRED PROBES	OPTIONAL PROBES
Think about other professional development workshops (apart from FoodMASTER) you have attended.	*Can you explain this more?* *Can you give an example?* *Can you think of anything else?* *I'm looking for where you might have gathered this information. Do you remember where you got this information?*

CLOSING:

Thank you for sharing with me today! We appreciate your help. I hope you have a great rest of the day!

Appendix E. FoodMASTER Teacher PD Consent Form

TEACHER INFORMED CONSENT

You are participating in a FoodMASTER (FM) professional development (PD) activity. FM educational researchers would like to observe your participation and collect your professional opinions about FM through a follow-up survey and interview. Participation in the observation, survey, and follow up interview process is completely voluntary and does not impact your participation in current or future FM PD.

While observation, surveying, and interviews will take place as a normal component of the FoodMASTER professional development experience, if you choose not to participate, data collected from you will not be included in any research manuscripts or reports. If you select to participate, all of the data collected will be confidential; your individual answers will not be identified in any reports. All information will be shared/presented in summary form only.

You have already received the benefit of the FM PD. The benefit of participating in the interview is that you will be helping others by informing future FM PD and programming. You will also be helping graduate students develop research skills and complete research projects.

If you have questions at any time about the study, you may contact the researcher, Melani Duffrin, PhD, RD, Professor, School of Interdisciplinary Health Professions, mduffrin@niu.edu, (815) 753-5118. If you have any questions regarding your rights as a participant, please contact NIU's Office of Research Compliance, Integrity, and Safety (815-753-8588).

Consent To Participate:
I have read (or had read to me) all of the above information. I have had an opportunity to ask questions about things in this research I did not understand and have received satisfactory answers. I know that I can stop taking part in this study at any time. By signing this informed consent form, I am not giving up any of my rights. I have been given a copy of this consent document, and it is mine to keep.

____

Teacher Name (please print)

____

Teacher Signature **Date**

Appendix F. FoodMASTER Teacher PD Observation Checklist

Number of Teachers Present: ______
Time Workshop Began: ______ Time Workshop Ended: ______ Total Time: ______

Participant Involvement	Yes	No	N/A
1. Did the teachers effectively work with others to complete the activities?			
Observations:			
2. Did the activities help the teachers understand concepts?			
Observations:			
4. Did the teachers engage in the content?			
Observations:			
Effective Instruction			
5. Did the teacher(s) interact with presenters appropriately and responsively?			
Observations:			
6. Did the presenters(s) answer questions effectively?			
Observations:			
7. Did the presenters(s) display appropriate knowledge and/or preparation for lesson?			
Observations:			

Effective Instruction	Yes	No	N/A
8. Was there more than presenter implementing the workshop?			
If so, did the presenters work together cohesively as a team?			
Observations:			
Lesson Completion			
9. Was the lesson workshop as intended by the FoodMASTER Initiative?			
Observations:			

10. Were there any barriers or challenges?			
Observations:			
11. Was the workshop completed in the prescribed time period?			
Observations:			
12. Were all components of the workshop completed?			
Observations:			
13. Were proper resources utilized to sustain workshop activities? If not, were they available?			
Observations:			

Expand on workshop environment (i.e. structure):

Appendix G. IRB Approval

NORTH CAROLINA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD FOR THE USE OF HUMAN SUBJECTS IN RESEARCH
SUBMISSION FOR NEW STUDIES

Protocol Number 18009

Project Title

Exploring the role of in-service teacher professional development on teacher perceptions of a food and nutrition professional development workshop

IRB File Number:

Original Approval Date:

09/17/2019

Approval Period

09/17/2019 - 01/01/2100

Source of funding (provide name of funder not account number):

NCSU Faculty point of contact for this protocol:NB: only this person has authority to submit the protocol

Bowles, Tuere A.: Educational Leadership, Policy, and Human Development (ELPHD)

Does any investigator associated with this project have a significant financial interest in, or other conflict of interest involving, the sponsor of this project? (Answer No if this project is not sponsored)

No

Is this conflict managed with a written management plan, and is the management plan being properly followed?

No

Preliminary Review Determination

Category:

Expedited 5

Appendix H. FoodMASTER FAN Workshop Focus Group Code Book

Categories	Subcategories	Description	Quote
Effective PD strategies	Hands-on	Includes specific reference to hands-on activities during PD experiences.	"The ones [PD experiences] where I was most engaged, and the ones where I was physically hands-on doing it versus listening to go through it where I got-- where the talk was minimal and me doing was maximum."
	Engaging Presenters	Includes reference to presenters who utilize multiple presentation methods, engage with participants during activities, have expert knowledge, are able to connect with participants and understand their needs (in the classroom and during the PD experience).	"You're just kind of talking and working with the people in the group and you're not being talked at the whole time"
	Informal	Includes reference to PD experience that were informal, casual, laid back, and less strict.	"I prefer sessions-- stuff like this where it's more informal, more casual."
	Collaboration	Includes reference to group work or working with other professionals to complete activities or talk about experiences in the classroom.	"I like hands-on. I like working with a group."
	Online Communities	Includes reference to the use on online resources including networking, working together, and discussion.	"I think, you know, being in a digital age, having an online resource for everybody to, you know, networking, work together, share best practices and experience in the classroom. You know, and what one school or district is doing versus what somebody else is doing, and to be able to just, you know, post and share that

			information would be-- and resources is available would be a huge, you know”
Ineffective PD strategies	Formal Presentations	Includes reference to presenter only use traditional lecture presentation during PD experience.	“I think that ineffective is when you're sitting there and you're in an, in a location you're listening for six hours and it's more of a formal, a boring lecture as opposed to hands-on.”
	Monotone Presenters	Includes reference to presenters which do not change their tone of voice or sound as if they are reading straight from the text.	“he's very monotone. It was just everything was written down. He read right out the paper.”
	Mandated	Includes reference to mandating of PD attendance even when the content is not related to their teaching.	“…we go to sometimes [to] professional develop-development that, say, the district sets up that doesn't exactly apply to your group.”
Effective Elements of FM PD	Simplicity	Includes reference to ease of activities to understand and implement during the PD experience.	“The ease of the activities. None of the activities were hard to do but they could be easily applied.”
	Student Activities	Includes reference to participants doing what the students would do in the classroom.	I really appreciate it, the hands-on demonstration. Like giving me what the kids would be doing.”
	Connection	Includes reference making connections between food and science or math.	“Actually hearing what you had to say about the different food groups and then giving a concrete scientific experiment to sink it into your brain”
FM PD Improvement	Location	Includes specific reference to having kitchen and sink space.	“It would have been easier, and I agree, if they had, maybe a kitchen available for you”
Teaching	Lesson Preparation Details	Includes references to teacher instructions and resources to adequately prepare and implement the activities.	“I appreciate how the lessons are set up and that it says explicitly what materials there are. I can see real quickly if I-- if it have some of those things.”
	Standard Alignment	Includes specific reference to activity alignment to standards.	“…I would wanna say what I would like to see would be is, uh, there is such a push with the

			standards that to see the activities aligned to, hey, this is how this activity can correlate to the standard."
	Ease of Implementation	Includes reference to ease of activities to understand and implement during in the classroom.	"The ease of the activities. None of the activities were hard to do but they could be easily applied. And, you know, it's household items so it's not anything new equipment or anything you would have to buy…"
	Everyday Learning	Includes activities which are relatable to everyday life application.	"I think it's-- you know, it's a real-world application of using, you know, fractions for recipes in measuring."