INFLUENCE OF SUBJECT TAUGHT (STEM), TITLE I, AND GRADE LEVEL OF INSTRUCTION FOR COMPONENTS IN AN EFFECTIVE PROFESSIONAL DEVELOPMENT DESIGN

by

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This dissertation was prepared under the direction of the candidate's advisor, Dr. David Devraj Kumar, Department of Curriculum, Culture, and Educational Inquiry, and has been approved by the members of her supervisory committee. It was submitted to the faculty of the College of Education and was accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

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ABSTRACT

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Professional development has been deemed ineffective for several decades. This ineffectiveness could stem from the one-size-fits-all professional development designs, and the inconsistencies and contradictions pointed out in professional development research (which is used to create these designs). Investigating how subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle and high) could influence teachers' preferences regarding components included in an effective design is a step toward resolving some of these inconsistencies. The research design was an embedded mixed method – an overall causal-comparative design embedded with interviews. Interviews determined teachers' perceptions of an effective professional development design. The survey investigated preferences for nine components: content knowledge, pedagogical knowledge, active learning, duration, alignment with goals and policies, follow-up, collaboration, support, and resources (tangible and intangible).

In the interviews, teachers communicated a need for differentiation based on grade level of instruction, Tittle I status of the school, and subject taught, with high percentages of agreement with the final questions of the survey. The ordinal logistic regression indicated that subject taught and Title I status of the school did not have a statistically significant effect on the dependent variable. Breaking up participants according to grade level of instruction (elementary versus secondary) had a statistically significant effect on teachers' preferences regarding the components included in an effective professional development design. This indicated that professional development should be differentiated based on elementary and secondary instruction.

When the researcher reviewed the components, some showed that the independent variables, Title I status of the school and grade level of instruction had a statistically significant effect. Although the ordinal logistic regression revealed a lack of statistical significance, percent differences indicated that factors such as subject taught, Title I status of the school, and grade level of instruction influenced teachers' preferences regarding specific components in an effective professional development design. These findings illustrate promise that in a larger study, statistical significance might be present. Thus, professional development should be differentiated based on subject taught, Title I status of the school, and grade level of instruction.

Keywords: Professional development, Title I, STEM, grade level of instruction, differentiation

DEDICATION

To my brothers, Andres and Gabriel. I am so blessed to be a big sister to you both.

Know that even with the crocodile tears and flying forks, I still love you!

INFLUENCE OF SUBJECT TAUGHT (STEM), TITLE I, AND GRADE LEVEL OF INSTRUCTION FOR COMPONENTS IN AN EFFECTIVE PROFESSIONAL DEVELOPMENT DESIGN

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I. INTRODUCTION

Professional development is a highly studied area in education. Some of the reasons for the ample research on professional development include policies requiring high quality professional development, the creation of rigorous standards, and national assessments that show a need to improve education. Research on professional development occurred at a national level; studies conducted involved hundreds of participants. At a district level, research was conducted on a much smaller scale. But, as Thomas Guskey (2003) has pointed out, even though there is much research on professional development, most of the research studies vary widely; results are "inconsistent and sometimes contradictory" (p. 479). One inconsistency is the lack of rigorous investigation between noted characteristics and student learning outcomes. Professional development research has, to date, shown a "lack of concern to gather reliable evidence on effectiveness" (Guskey, 2009, p. 227). The discrepancies in research may be a reason for a one-size-fits-all mentality, which has been applied to professional development designs. This has resulted in teachers' dissatisfaction with the professional development they are receiving (Bill & Melinda Gates Foundation, 2014). Their discontent stems from somewhere legitimate.

This research aimed to determine if a failure to structure professional development designs to meet the needs of the intended audience has created dissatisfaction. The investigation used an embedded mixed method that occurred in two stages. First, interviews were conducted to determine if teachers perceived the nine

components chosen by the researcher to be part of an effective professional development design. Then, the verified components were used in a survey, which investigated if teachers' preferences for the inclusion of components was influenced by subject taught (STEM and non-STEM), the Title I status of the school (Title I and non-Title I), and the grade level of instruction (elementary, middle and high).

Background of the Study

The need for effective professional development was recognized early on in educational policies and research. The Elementary and Secondary Education Act of 1965 named professional development a program under national significance (§ 2, §303). The National Commission on Excellence in Education's *A Nation at Risk* (1983) called for an 11-month contract for teachers to allow time for professional development. In a science education research study, *Project Synthesis*, professional development was for "continuous professional growth… to maintain a valid curriculum and appropriate teaching practices" (Norris & Hannapel, 1980, p. 4-9).

Over the past several decades, many reform efforts have been made. These efforts have been intended to improve existing professional development, and to create new professional development (Choy, Chen, & Bugarin, 2006). However, the fact that there has been an abundance of professional development does not mean it has been high-quality or effective. In fact, the National Center for Education Statistics reported that although initiatives to improve professional development have been ample, professional development is still "viewed as inadequate by many scholars and policymakers" (Henke, Chen, & Geis, 2000, p. 2).

To determine whether or not professional development was effective, the most common units of measurement used in research studies were improvements in teachers' knowledge and instructional practice and student learning outcomes (Borko, 2004; Guskey, 2003; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Researchers used these units of measurement to piece together the various parts of professional development, and determine which components were effective verses ineffective. The research created many publications of effective professional development designs and components that should be included in the overall structure. Some of these components were active learning, content specificity, alignment with standards, pedagogy, duration, collaboration, and support (Birman, Desimone, Porter, & Garet, 2000; Darling-Hammond & Richardson, 2009; Garet, Porter, Desimone, Birman, & Yoon, 2001; Guskey, 2003; Loucks-Horsley, Stiles, Mundry, Love, & Hewson, 2010; Wei et el., 2009). Research identifying these components was not the only criteria employed to construct professional development designs; specific standards for professional development and policies were applied as well.

Organizations like the National Staff Development Council -- now learning-forward -- developed standards for professional development. The Standards for Staff Development, now in its third iteration and called Standards for Professional Learning (learning forward, 2009), helped to mold professional development designs. Education policies such as No Child Left Behind and The Improving America's Schools Act of 1994 were further efforts to create an effective professional development design, that required a framework for high-quality professional development and were tied to challenging state academic standards (Improving America's Schools Act, 1994). The goals for effective

professional development had been established through policies and standards. The components included in the design were supported by research, but there were still issues that needed to be addressed, such as how professional development should be delivered to teachers.

Professional development was delivered in the forms of conferences, workshops, college courses, collaboration during common planning, and/or mentoring. The most common form of professional development included workshops structured as either "training models" (referred to as traditional) or "professional learning" (referred to as collaborative) (Banilower, Smith, Weiss, Malzahn, Campbell, & Weis, 2013; Bill & Melinda Gates Foundation, 2014; Butler, Lauscher, Jarvis-Selinger, & Beckingham, 2004; Lieberman & Miller, 2014). Traditional workshops presented the theory, modeled the strategy or skill, required participants to practice the skill, and provided feedback (Showers, Joyce, & Bennett, 1987). Those who facilitated teaching-collaborative workshops considered how the content was taught and connected to the classroom. Workshops included mentoring and reflection (Borko & Putnam, 1998; Mraz & Kissel, 2014; Shulman, 1986). Even though these two workshop structures employed components indicated by research as necessary for an effective design, professional development workshops became known as "drive-by workshops" that were short-term and "unlikely to impact teaching practices and student outcomes" (Darling-Hammond & Richardson, 2009; Wei, Darling-Hammond, & Adamson, 2010, p. 1). This has resulted in few teachers feeling that professional development has met their needs and many finding professional development irrelevant, ineffective, and not connected to content (Bill & Melinda Gate Foundation, 2014). This disgruntlement with professional

development workshops could be a result of lack of differentiation -- research that fails to investigate teachers' needs for professional development based on the subject they teach, the Title I status of the school, and the grade level of instruction.

Over the past decade, education policies have emphasized the development of rigorous standards. This has created the standards-based reform efforts seen in the construction of professional development designs. The standards-based reform required teachers' practices to align with standards, because research showed that changing teacher practice impacted the classroom, as measured by student achievement on standardized tests (Guskey, 2002; Nye, Konstantopoulos & Hedges, 2004). Creating professional development is costly, and trying to obtain an estimated amount of funding needed for professional development is difficult (Odden, Archibald, Fermanich & Gallagher, 2002). However, certain sources of funding can be identified. Examples of these sources include the federal educational policy, No Child Left Behind of 2001, which allotted $2.6 million for state grants to improve teacher quality, and the National Science Foundation, which provided the majority of the grants for professional development in Science, Technology, Engineering, and Mathematics (Gonzalez, 2012; Kuenzi, 2008). The funding created an abundance of professional development for teachers, especially in STEM, yet teachers do not appear -- based on teachers' learning gains (measured through self-evaluation) and student achievement (TNTP reimage teaching, 2015; Wei et al., 2010) -- to be reaching mastery of core instructional techniques from year to year. Therefore, the issue must lie within the design of professional development.

Effective professional development design components used in workshops came from copious research on the topic. Guskey (2003) investigated 13 lists pulled from major publications and discovered 21 different characteristics or components found in an effective professional development design. Other researchers like Darling-Hammond, Richardson, and Wilson have also reviewed multiple research studies, shedding further light on which components made professional development effective. In addition, they created lists of their own. The components identified by these researchers included several that overlapped, such as content-specific and collaboration, creating an overall structure for professional development that contained both similarities and differences. Depending on the research for effective professional development components at a given time, more emphasis would be placed on a specific component during the training, as research indicated its strengths and subsequent need to be included in the design.

For example, there was great focus on content-specific professional development and a decline in the intensity of the other components because research indicated that teachers lacked content knowledge (Banilower et al., 2013; Wei et al., 2010). Further investigation revealed that teachers who felt there was a lack of content knowledge in professional development were elementary teachers, while secondary teachers felt that they had a strong content base (Banilower et al., 2013). Another study showed that secondary teachers had expressed a desire to see pedagogical strategies emphasized in their professional development (Banilower, Heck, & Weiss, 2007). However, teachers were receiving professional development that emphasized content knowledge, regardless of grade level. Though these designs are identified as research-based professional

development, research clearly indicated that the elementary teachers' desires for professional development differed from secondary teachers' desires. This adds to the argument against a one-size-fits-all mentality and creating a need for differentiated professional development.

Differentiated instruction,

> "is an organized yet flexible approach to teaching and learning in which teachers and students purposefully select and modify instructional and curricular content, process, product, and environment according to student readiness, interests, and learning profiles in order to maximize student learning" (Woodland, 2014).

Experts, such as the National Board for Professional Teaching Standards and the National Association of Secondary School Principals, have indicated that differentiated instruction is beneficial for the learner (Tomlinson & Imbeau, 2010). Providing tailored professional development could enhance the overall experience for the teacher, leading to improved teaching practices. Studies have shown that a well-designed professional development could improve teaching practices and student achievement (Borko, 2004; Fishman, Marx, Best & Tal, 2003; Wei et al., 2010). However, teachers are receiving homogeneous professional development.

The ambiguous use of research in constructing professional development design suggested a need for a research study that investigated if factors such as grade level of instruction (elementary, middle, and high), Title I status of the school (Title I and non-Title I), and subject taught (STEM and non-STEM) influenced teachers' preferences regarding components included in an effective professional development design. These

differences found in the makeup of the instructional staff in a district led the researcher to investigate the following questions:

Research Questions

1. What are perceptions of effective professional development design components among K-12 school teachers in a large public-school district located in the southeastern part of the United States?
2. Do factors such as subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, high) influence teachers' preferences regarding the components included in an effective professional development design?
    a. Does subject taught (STEM and non-STEM) influence preferences regarding components that should be included in an effective professional development design?
    b. What are the differences, regarding preferences for components that should be included in an effective professional development design, between the teachers at Title I schools and teachers at non-Title I schools?
    c. What are primary and secondary teachers' preferences regarding which components are part of effective professional development design?
    d. Are the differences in the components of the professional development design between STEM and non-STEM teachers a function of the Title I status of the school (Title I and non-Title I)?

Problem Statement

The one-size-fits-all model has created inconsistencies in studies for professional development, like Phase II of a multi-year study, *The Status of Professional Development in the United States* (2009). This study generated questions based on findings from the School and Staff Surveys collected in 2003-2004 and 2007-2008. They found that professional development increased its focus more heavily on content-specific matter; elementary teachers valued it more than high school teachers did (Wei et al., 2010). A literature review investigated 1,300 studies and found that only nine of the studies, all elementary instructional level, met the *What Works Clearinghouse Evidence of Standards* (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). This comes back to Guskey's writings regarding research being inconsistent, and researchers' "lack of concern to gather reliable evidence on effectiveness" (Guskey, 2009, p. 227). For example, elementary teachers indicated weakness in content knowledge for mathematics, whereas high school teachers did not (Banilower et al., 2013). Yet research has shown that content knowledge is a necessary component in an effective professional development design for all grade levels (Darling-Hammond & Richardson, 2009). These findings indicate that much of the research on effective professional development components used elementary grade level as the subject matter. It implied that teachers on the middle and high school level of instruction had the same needs. The one-size-fits-all mentality could be the cause for some of the teacher dissatisfaction with professional development. This raised an important question: Do instructors of different grade levels desire professional development to contain the same components, or does the grade level taught by the educator impact component choices?

Though not very well researched, there are some studies that indicated that discipline-specific concepts taught in professional development improved teacher practice (Banilower, Heck, & Weiss, 2007; Johnson, Fargo, & Kahle, 2010; Saxe, Gearhart, & Nasir, 2001). Another study conducted showed how teachers' content knowledge affected student achievement (Blank, de las Alas, & Smith, 2008). The research used to demonstrate that content-specific professional development improved teacher practice and student achievement was conducted using science and mathematics, but has been applied to all subject matters. How do researchers know that content-specific professional development also improved teacher practice and student achievement for those teachers of social studies or English? Raising the question: Does the subject taught by the teacher affect what components he or she desired in a professional development design?

Another aspect that should be taken into consideration when designing professional development is the Title I status of the school. Title I schools tend to be staffed with high numbers of less experienced teachers, which can impact student achievement (Carter, 1984; Clotfelter, Ladd, & Vigdor, 2007; Puma, Jones, Rock, & Fernandez, 1993). Research showed that teachers at Title I schools have received more professional development, and participated in professional development more frequently, than teachers at non-Title I schools. However, student achievement is stagnant (Carter, 1984; Deke, Dragoset, Bogen, & Gill, 2012; Wei et al., 2010). No Child Left Behind allocated funds and mandated professional development for Title I schools. This could, in part, justify the higher participation, but does not explain why student achievement is stagnant. Professional development research is inconsistent and sometimes

contradictory, which has led to one-size-fits-all designs that have implied that no matter the grade level of instruction, the subject taught by the teacher, or the Title I status of the school, all professional development needs are the same.

Recent research indicated that the professional development designs offered were not consistently helping teachers improve in their teaching practices and were considered ineffectual by educators (TNTP reimage teaching, 2015). The one-size-fits-all professional development designs lack differentiation; which research has shown can maximize student learning. This can lead to improved teacher practice, and result in enhanced student achievement (Borko, 2004; Fishman, Marx, Best & Tal, 2003; Tomlinson & Imbeau, 2010; Wei et al., 2010; Woodland, 2014). So why are professional development designs functioning under the one-size-fits-all mentality? Why has there been no investigation on teachers' professional development needs based on the subject taught, grade level of instruction, or the Title I status of the school?

To delve further into this question, the researcher chose nine components out of the 21 Guskey (2003) deemed effective to be used in the study. To ensure that the components chosen were what teachers perceived as part of an effective professional development design, interviews were conducted. This allowed the researcher to construct a more reliable survey. The researcher hypothesized that teachers' perceptions of components included in an effective professional development design would align with those chosen by the researcher. In addition, the preference for components included in an effective professional development design for teachers would be influenced by subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high).

Purpose of the Study

The embedded mixed method design refined our current knowledge and provided a more complete understanding of teachers' preferences regarding which components should be part of an effective professional development design. The mixed method design shed light onto whether factors such as subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influenced these preferences. An embedded mixed method was implemented because the design entrenched one type of data into the methodology framework of another data type (Caracelli & Greene, 1993; Creswell & Plano Clark, 2011). This allowed the researcher to use qualitative data to first determine if teachers' perceptions of effective professional development design components aligned with, or were very similar to, the components chosen by the researcher from the literature. Then, having used a quantitative data collection method, the researcher was able to determine if variations existed in teachers' preferences regarding components included in an effective professional development design based on subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high).

Qualitative data collected from interviews determined if the nine components selected by the researcher were perceived as part of an effective professional development design by educators in a large public-school district located in the southeastern part of the United States. If any variations from these nine components chosen arose from the qualitative data, the researcher would have included this in the survey. The survey was constructed using the nine components, chosen by the

researcher. The quantitative data collected from the survey was used to determine if design component preferences for teachers in a large public-school district located in the southeastern part of the United States were influenced by subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, high). The rationale for collecting both quantitative and qualitative data allowed the researcher to first determine if the nine components chosen aligned with teachers' perceptions of an effective professional development design. Then the data from the qualitative method permitted the researcher to construct a much more reliable survey that determined whether factors such as subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, high) influenced which components teachers preferred to include in an effective professional development design.

Theoretical Framework

The theoretical framework for this study is multifold. The study used tenets of Kurt Lewin's (1947) Change Theory to support the need to identify teachers' perceptions of the components included in an effective professional development design. Secondly, Etienne Wenger's (1998) Communities of Practice aided in the idea that subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influenced teachers' preferences regarding components incorporated in an effective professional development design. Lastly, the components chosen for this study, which the literature had signified as part of an effective professional development design, are reflected in Louks-Horsley, Stiles, Mundry, Love, & Hewson's (2010) Professional Development Framework, Ball

and Cohen's (1999) Practice Based Theory, and Darling-Hammond and Richardson's (2009) High-Quality Professional Development: Content, Context, and Design.

Change theory. Kurt Lewin's plan for change was comprised of four parts: Field Theory, Group Dynamics, Action Research, and the Three-step model of Change. Lewin's Field Theory research showed how much critical data -- regarding investigation of behavior -- was overlooked when the environment was not taken into account (Lewin, 1951). The Group Dynamics postulated that the problems of individual behavior and attitude were a reflection of the groups' attitudes and level of satisfaction (Kariel, 1956; Lewin, 1951; Lewin & Lippitt, 1938). The research from these investigations led to the action of change, which was used to develop evaluations. Nevertheless, there were still gaps in the theory. Further research was conducted to compare conditions and effects of social reforms, resulting in social action classified as Lewin's Action Research (Burnes, 2004; Lewin, 1948). These three parts were not enough to facilitate change. Lewin introduced a three-step change model in 1948, which was used to investigate both the behavior and the environment of a group. The model suggested that there were opposing forces -- forces that facilitated change in one desired direction, and other forces that pushed change for a group in the opposite direction. Lewin's Three-step Model of Change was a 'plan for change' that had three distinct parts investigating the opposing forces: *Unfreeze*, *Moving*, and *Refreeze*.

The first step in Lewin's model was to *unfreeze* the unwanted processes. If an organization were in what he called the "inertia" state, implying an inability to change (Burnes, 2012; Lewin, 1947), it would have to remove the inertia, or "unfreeze." This

way, forces directed toward the existing behavior would be minimized and a method to help let go of an old, counterproductive pattern would be discovered (Kaminski, 2011; Kritsonis, 2004; Lewin, 1947). Before the next step could occur, participants would have to be persuaded that the status quo was not beneficial. An atmosphere of transparency should be implemented to help motivate and prepare participants for the change. There would need to be a dialogue between those who would be affected by the change, and those creating it. Team-building and brainstorming should be included in the process to help strengthen the buy-in to the change (Kaminski, 2011; Lewin, 1947). The "change-targeted group" would need to be "re-educated"; this would pave the way for change (Lewin, 1947; Lewin & Grabbe, 1945). Each of these things would need to be tailored specifically to the groups that change was desired for (Lewin, 1947). The groups would then be able to move onto the next stage of the three-step change model.

During the second step, *moving*, the change would already be occurring; the change-targeted group would have to be convinced that the new way was better. According to Lewin, there are three things necessary in order for change to occur. First, change must be voluntary; those impacted should be included in the development process (Lewin, 1947, 1951). This should begin in the *unfreeze* stage. Secondly, the change must be a learning process that the group encounters together. Lastly, the learning process must continuously take into account group dynamics and incorporate them into the desired change (Burnes, 2012; Lewin, 1947). If an organization follows these steps, it should be able to create the desired change. The last step of the Three-step Model of Change is to *refreeze* the process. To assure that participants do not revert to old ways, the new values and traditions have to become the

strongest force. This is accomplished through rewards and support that persist until the next major change (Kaminski, 2011; Kritsonis, 2004; Lewin, 1947).

Education undergoes change quite frequently and the change process usually does not include members of the change-targeted group: teachers. The change, whether it is a teaching method or new standards, is disseminated to teachers most often through professional development. There is little research that has included the change-targeted group in the developmental process. Also, the construction of professional development designs has not fully taken into account the various group dynamics that exist within the K-12 public education system, lumping everyone together. This made Lewin's Change Theory, specifically the Three-step Model of Change, especially germane for this study. The purpose of the study was to investigate if teachers' preferences regarding components included in an effective professional development design were influenced by the subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and the grade level of instruction (elementary, middle, and high). Most importantly, this study *included* the change-targeted group: teachers.

Community of practice theory. In 1991, Jean Lave and Etienne Wenger developed a theory to enhance the understanding of learning that occurred during informal and situated social interactions: the Community of Practice Theory (Cox, 2005). A community of practice includes people involved in a mutual engagement. Engagement in the community of practice is described as the inclusion of someone in what matters (Wenger, 1998). Lave and Wenger (1991) define the community of practice as "a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice" (p.

98). To achieve communities of practice, there are three things that must be present: First, there is a shared domain interest. Next, there is a community, in which the members interact and engage in shared activities, share information, and work together. A community of practice develops a repertoire over time that includes routines, ways of doing certain things, and action steps to accomplish something (Wenger, 1998). Lastly, a practice or a shared repertoire, using what the community understood or learned through regular interaction, forms. When getting together, members tell stories of how similar problems were handled, and provide tools and resources to other members. This interaction helps to develop the practice over time (Lave & Wenger, 1991; Wenger, 1998).

Lave and Wenger (1991) refer to practice as "situated activity and situated learning" (p. 33) because if mandated, the members would adapt the practice according to their own responses (Wenger, 1998). This created the commonality found within the community and the practice (or the "community of practice"). The definition of a community of practice can be found in the instructional staff within schools and the district. Communities of practice are formed by the subject that educators teach, the Title I status of the school, and the grade level of instruction. The community of practice theory points out the need to research the preferences of the communities formed, because although they share a common language, practices, and some repertoire, the practice for each community has been influenced by its members' experiences in the groups. Subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) inform these experiences.

Professional development framework. There have been several effective professional development designs models shaped by researchers like Thomas Guskey (2003), The Center for Public Education (Gulamhussein, 2013), and learning forward (2009). For this study, the theoretical models adopted were Loucks-Horsley et al.'s (2010) Professional Development Framework, Ball and Cohen's (1999) Practiced Based Theory, and Darling-Hammond and Richardson's (2009) High-Quality Professional Development: Content, Context, and Design.

Loucks-Horsley et al. (2010) Professional Development Framework is comprised of many components, such as continuous reflection and revision, that appear to be part of an effective professional development design. Their framework stressed that professional development should be centered around analyzing student and other data, and should include a shared vision to start with. Strategies that encompass logistics and the agenda of what would occur during the professional development should be developed. The framework is completed with an evaluation, reflection, and revision for the next professional development (Loucks-Horsley et al., 2010).

Ball and Cohen's (1999) Practice Based Theory contained three requirements: First, it was necessary for teachers to know what they taught well enough to lay the foundation for students. Secondly, the professional development needed to build upon the skills, knowledge, and values that teachers already possessed. Lastly, the professional development should have used tools such as professional analysis, reflection, and professional discourse (Ball & Cohen, 1999). Incorporating both the Professional Development Framework and the Practice Based Theory into the professional

development design for this study encompassed a majority of the components indicated as being part of an effective professional development design, but not all.

The last theoretical framework model used in this study was Darling-Hammond and Richardson's (2009) High-Quality Professional Development: Content, Context, and Design. *Content* centered on student learning and emphasized active teaching and reflection (Darling-Hammond & McLaughlin, 2011). Part of *Content* was pedagogical skills development, content knowledge emphasis, and teacher self-efficacy enhancement (Darling-Hammond & Richardson, 2009). Also integrated in *Content* was support in the form of traditional professional development, community-based activities, and direct engagement in the learning process (Saxe et al., 2001). *Context* was alignment with school reform efforts, on-demand support, and collaboration (Darling-Hammond & Richardson, 2009). High Quality Professional Development: *Design* was broken into active learning, modeling new strategies, and professional development that was sustained and intensive (more than 14 hours) (Darling-Hammond & Richardson, 2009; Yoon et al., 2007).

By combining these theoretical framework models, the researcher chose nine components to construct the teacher survey: 1. Content knowledge, 2. Pedagogical knowledge, 3. Active learning, 4. Alignment with policies and goals, 5. Duration, 6. Follow-up, 7. Resources (broken into tangible and intangible), 8. Collaboration, and 9. Support. Each of these theoretical framework models expressed various components, but these nine components were most prevalent in the literature. Because no one professional development design model is a like, only similar, interviews were conducted to determine if these nine components were what teachers perceived as the foundation for an effective

professional development design. The survey used to investigate if teachers' preferences were influenced by subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) was constructed keeping these theoretical framework models in mind.

Scope and Limitations

The scope of the study included full-time K-12 teachers employed by a large public-school district located in the southeastern part of the United States. These participants included teachers who instructed students in grades kindergarten through twelve, and partook in at least one professional development that the district or the school provided. A limitation for this research was researcher bias, because the data source is from the same school district that employs the researcher. The researcher acknowledged that this project lent itself to a larger data sample to more thoroughly examine alignment of teachers' perceptions of effective professional development design components, as well as whether subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influenced preferences regarding components included in an effective professional development design. In addition, the time constraint for participants to respond to the survey and the possibility of respondents being forced into particular response categories placed limitations on the instrument (Simon & Goes, 2013). Another limitation of this study included the researcher's selection of schools for the interviews. She purposely selected and stratified schools based on grade level and Title I status.

Delimitations and Strengths

Several delimitations for this research were as follows: Teachers must be instructing students that are in grades kindergarten through twelfth, and they must be employed with the district where the research is being conducted. To reduce the possibility of an outlier, teachers must have participated in one professional development program offered by the district or the school.

This research study did not investigate charter schools, schools classified as ESE, and alternative schools located in the district. The rationale was to provide some homogeneity to the sample. These sites could have received funding or special accommodations due to their classification, and could have been used to augment professional development already taking place at the schools. Further delimitations occurred during the interview selection process. The researcher chose participants, based on certain criteria, from a purposefully selected list of schools. This helped to minimize the possibility of unintended favoritism.

This study had several strengths: One strength is that the researcher conducted the study within a very large school district. This district has thousands of employees. Another strength is the diversity of the district's population. Participants are from all over the world – over 150 different countries – and speak over 100 different languages and dialects.

Significance

The significance of the study was to provide research that demonstrated a need to tailor components in a professional development design to the intended audience, based on subject taught (STEM and non-STEM), Title I status of the school (Title I and non-

Title I), and grade level of instruction (elementary, middle, and high). The findings of this research could help with budgetary issues that have arisen due to changes in funding for professional development by educational policy. The implications of the study could allow creators of professional development to adapt already existing designs to fit the desired group's needs, minimizing one-size-fits-all workshops and providing effective professional development.

Teachers are asked to provide differentiated instruction to their students because of various learning styles, speeds, and abilities. Professional development programs should be approached in the same way, providing variances in the overall structure based on the audience's needs. These needs vary according to subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high). Differentiated professional development has the possibility of positively impacting teacher growth and student achievement. This study could be beneficial to the participants (teachers), school administrators, the district's department of professional development, and the State's education professional development department.

This research could bring a clearer connection between professional development design and the participants' preferences regarding components included in an effective design to the field: a significant contribution. Another significant contribution to the literature includes research that investigated professional development administered to STEM teachers and Title I schools.

Definition of Terms

Effective Defined as "producing or capable of producing a desired result" (Effective, n.d.). Effective professional development contained the components identified in the literature and research as "effective." The components chosen for this research have been studied and ultimately identified as effective based on student achievement and/or teacher change (Borko, 2004; Darling-Hammond & Richards, 2009; Guskey, 2003; Wei et al., 2009).

Grade level of instruction Grade level of instruction is broken into primary and secondary grade levels. The primary is elementary level of instruction -- kindergarten through fifth grades. Secondary is divided into middle (sixth through eighth grades) and high (ninth through twelfth grades) levels of instruction.

Influence Influence is the effect by indirect or intangible means on the development of a professional development design (Influence, n.d.).

non-STEM Non-STEM refers to the "core curricular courses" (identified by the Florida Statue), not including Science, Technology, Engineering or Mathematics courses, necessary for promotion to the next grade level or graduation. These courses are English Language Arts/Reading and Social Studies for grades kindergarten through third (§1003.01), English Language Arts and Social Studies for grades fourth through eighth (§1003.4156), and English Language Arts, Social Studies, Physical Education, and Performing Arts, Speech and Debate, and Practical Arts (§1003.4282) for grades ninth through twelfth (Fla. Stat., 2016).

Perceptions Teacher perceptions are based on several theories of perception originating from the sciences and social sciences. According to action-based theories of perception, movements of the body, either passive or active, generate functional information used for perception. Susan Hurley's "Input Output Picture" stated that, "movement can alter sensory inputs and so result in different perceptions [output]" (Hurley, 1998, p. 342). The components that are included in a professional development design are inputs that can alter the output (i.e. how the teacher delivers content). In the philosophy of perception, Direct Realists hold that perception is a direct awareness of mind; they "deny that the perception of these physical objects or events requires a prior awareness" (Morvan, 2004). Thus, direct experiences (i.e. Title I status of the school, grade level of instruction) generate perceptions that a teacher might not be aware of throughout his/her career. The result might be an altered output (i.e. professional development component preferences).

Professional Development	For this study, professional development was defined as a continuous learning experience that had a direct and indirect impact on the teacher and the teacher's commitment as an agent for change in his/her classroom.
STEM	For this research, a STEM teacher is defined as an educator who has taught at least one course of Science, Technology, Engineering, and/or Mathematics. These courses are referred to as "core curricular courses," stipulated by Florida Statue for education as necessary for the promotion to the next grade level or graduation.
Title I	Schools that are identified as Title I have a high percentage of students who come from economically disadvantaged families -- Part A (Title I) of the Elementary and Secondary Education Act -- (United States Department of Education, 2015a). Title I status for this study is stated on the district's website; the school's "eligibility for Title I funding for this school year (FY17) is based on the school's percent of Free/Reduced Price Lunch eligible students as of December 18, 2015."

Chapter Summary

More than two decades ago, research indicated that professional development designs were ineffective (Henke, Chen, & Geis, 2000). More recently, professional development is still reported to be ineffective (Bill and Melinda Gates Foundation, 2014; TNTP reimage teaching, 2015). The cause for this ineffectiveness could be coming from the one-size-fits-all professional development designs and the inconsistencies and contradictions that Guskey (2003, 2009) pointed out in professional development research, which is used to create these designs. Investigating how subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) could influence teachers' preferences regarding components included in an effective design is a step in cleaning up some of the inconstancies found in professional development research. Also, having used Change

Theory and the Community of Practice to illuminate the ineffectiveness of one-size-fits-all professional development designs, this research study provided data to allow for the construction of differentiated professional development based on teachers' needs, eroding the one-size-fits-all design.

II. REVIEW OF LITERATURE

Using the theoretical framework of Change Theory, Community of Practice, Professional Development Framework, Practiced Based Theory, and High-Quality Professional Development: Content, Context, and Design, this study examined the influence that subject taught, Title I status of the school, and grade level of instruction had on teachers' preferences for components included in an effective professional development design.

The literature review was broken into four sections: The first section focused on components of an effective professional development design to underscore why the researcher chose these nine components. The second section centered on STEM education, the role educational polices played in creating professional development for STEM teachers, and the current state of STEM professional development. The third section examined research on Title I schools and the impact it has on professional development offerings and student achievement. The last section explored how grade levels influenced teachers' practice, the physiological development of students, and the importance of differentiated instruction.

Effective Professional Development Design Components

Putting together an effective professional development design is no easy feat. An analysis of reputable sources such as National Partnership for Excellence and Accountability in Teaching and the U.S. Department of Education resulted in a distinction of 21 characteristics or components that were identified as necessary for an

effective professional development design (Guskey, 2003). In a review of professional development for science teachers, ten characteristics were recognized and five emerged as the most prevalent: (i) focusing on specific content, (ii) engaging teachers in active learning, (iii) enabling the collective participation of teachers (sometimes administrators), (iv) coherence (aligned with other school policy and practice), and (v) sufficient duration (both in intensity and contact hours) (Darling-Hammond & Richardson, 2009; Wilson, 2013). *Professional Learning in the Learning Profession: A Status Report on Teacher Development in the U.S. and Abroad* (2009) divided the professional development design into content, context, and design, and each of these contained components. The National Comprehensive Center for Teacher Quality found five components included in their definition of effective professional development, which encompassed alignment with goals, modeling, active learning, collaboration, and follow-up (Archibald, Coggshall, Croft, & Goe, 2011).

Reading the literature on effective design components can be confusing and is not always constant. After review of many of the sources used in these major studies, it was found that there was a lack of consistency. Some examples of inconstancies were studies conducted in countries other than the one where the research was conducted, populations that ranged from pre-service to veteran teachers, and a mixture of elementary and secondary level. Also, the majority of the studies' subject matter focused on science and mathematics. For this study, the very same thing occurred to validate the selection of the components; the researcher used various subject matters, population, and grade levels. All research studies used for the literature review were conducted in the United States.

The nine components selected for this study's effective professional development design used parts of the theoretical frameworks put together by Loucks-Horsley et al.'s (2010) Professional Development Framework, Ball and Cohen's (1999) Practice Based Theory, and Darling-Hammond and Richardson's (2009) High-Quality Professional Development: Content, Context, and Design. This section of the literature review concentrated on research for the following nine components: content knowledge, pedagogical knowledge, active learning, alignment with goals and policies, duration, support, collaboration, resources, and follow-up.

Content Knowledge

Content knowledge is knowledge that is organized with relevant facts about concepts and principles within a specific domain (e.g. physics) and represents a rich understanding that encompasses not only what it is, but also how and why it is so (Shulman, 1986). According to Garet, Porter, Desimone, Birman, and Yoon (2001), content knowledge is a key feature for effective professional development design, and Table 1 neatly displays several studies to highlight content knowledge's importance in the design.

As the studies have shown, expertise in a content area depends on access to the knowledge and deficiencies, and has a direct correlation with a student's learning progress. Inclusion of content knowledge in professional development helped teachers to cultivate activities for instruction, and enhanced their ability to facilitate content knowledge in the classroom (citations in Table 1). Having strong content knowledge led to higher confidence; a well-developed content knowledge foundation allowed teachers to

"be able to transform that knowledge to a new situation in the future" (Pop, Dixon, & Groove, 2010, p. 131).

Table 1

Research Studies for the Component Content Knowledge

Aspects to highlight content knowledge importance	Research studies
Expertise	Darling-Hammond & Richardson, 2009; Irby, 1994; Putnam & Borko, 2000; Schmidt & Rikers, 2007; Shulman, 1986.
Student learning progress	Hill, Rowan, & Ball, 2005; National Science Board, 2004; Pasley, Weiss, Shimkus, & Smith, 2004; Rowan, Chiang, & Miller, 1997; van Driel, Berry, & Meirink, 2014.
Activity development and facilitation in the classroom	Mattheis, Ingram, Jensen, & Jackson, 2015; Roth et al., 2011; Seraphin, Philippoff, Parisky, Degnan, & Warren, 2013.
Increasing confidence through knowledge[a]	Asaad, 2015; Baxter & Ruzicka, Beghetto, & Livelybrooks, 2014; Ertmer & Ottenbreit-Leftwich, 2010; Grossman, Wilson, & Shulman, 1989; Li & Kulm, 2008; McDiarmid, Ball, & Anderson, 1989.

[a]The research study subjects for education were pre-service teachers.

Active Learning

Effective professional development designs position teachers as learners; opportunities have been provided for the educator to actively engage in meaningful analysis of teaching and learning (Birman, Desimone, Potter, & Garet, 2000). Learning by doing, or active learning, "enables teachers to make the leap from theory to accomplished practice (Darling-Hammond & McLaughlin, 2011, p. 83). If the goal of

the professional development is to teach a method of pedagogy, such as inquiry, then the participants should be immersed in activities that are inquiry-based. Active learning helps teachers comprehend information for their own learning needs and allows them to better explain content to others (Huffman, 2006; Mattheis et al., 2015; Roth et al., 2011). When participants were actively learning, it allowed them to develop their professional knowledge, increased their confidence in instructional abilities (measured as self-efficacy), and created within them a sense of ownership of the approach practiced (Baxter, Ruzicka, Beghetto, & Livelybrooks, 2014; Fallik, Eylon, & Rosenfeld, 2008; Jaipal-Jamani & Figg, 2015).

Pedagogical Knowledge

Lee Shulman's (1986) conceptualization of teacher knowledge included pedagogical content knowledge and described it as "ways of representing and formulating the subject that make it comprehensive to others" (p. 9). For educators to do this, they must first have solid foundations of content knowledge, receive instruction in methods to deliver this content knowledge, and finally, be given opportunities to practice delivering content through various pedagogical methods. Pedagogical methods taught in professional development range from technology usage, scaffolding, problem-based learning, and inquiry-based learning, to name a few. Research indicated that inclusion of pedagogical content knowledge in professional development enhanced educators' knowledge of teaching methods, showed changes in teaching practices, and was used almost immediately in the classroom (Desimone, Porter, Garet, Yoon, & Birman, 2002; Huffman, 2006; Seraphin et al., 2013). Professional development that helped teachers

develop pedagogical skills showed positive effects on practice, which students benefited from (Darling-Hammond & Richardson, 2009; Fallik, Eylon, & Rosenfeld, 2008).

Collaboration

Collaboration occurs when "teachers develop expertise not as isolated individuals but through job-embedded professional development, and as members of collaborative, interdisciplinary teams with common goals for student learning" (Hill, Stumbo, Paliokas, Hansen, & McWalters, 2010, p. 10). Collaborative reflection, problematizing, and sharing effective instructional practices were important in reshaping each teacher's view of his/her specific content knowledge and enhanced his/her learning (Fazio, 2009; Nelson, 2009; Wei et al., 2009). Technology, such as blogging, message boards, and emails, have created easier access for collaboration and has proven to have a positive impact on professional development training outcomes (Jaipal-Jamani & Figg, 2015; Luehmann & Tinelli, 2008). In the midst of professional development, on the school site after the professional development, and outside of the school site with additional educators, technology has created opportunities for collaboration to occur.

Alignment with Policy and Goals

According to several studies, professional development is more likely to be effective when aligned with policy or goals (Cohen & Hill, 2000; Garet et al., 2001; Penuel, Fishman, Gallagher, Korbak, & Lopez-Prado, 2008). In a summary report of four states' policies and strategies for professional development, "state policies… are among the key factors in implementing effective professional development" (Jaquith, Mindich, Wei, & Darling-Hammond, 2010, p. 4). When professional development is aligned with goals and policies, it reduces confusion and creates a shared vocabulary, as

well as opportunities for teachers to learn about standards that policy has mandated (Archibald, Coggshall, Croft, & Goe, 2011; Hill, 2001). Research has suggested that professional development, aligned with policy, has had a strong to a moderate effect on teachers' beliefs, knowledge, and classroom practice (Blank, Porter, & Smithson, 2001; Levitt, 2001; Swanson & Stevenson, 2002).

Follow-up

Loucks-Horsley et al.'s (2010) framework model demonstrated how reflection, which is to be prompted at the end of professional development, allowed the participants to begin again after reassessing and evaluating what they had learned. Participants were to reflect and "consider the interests that [were] most important to [them]" (Louks-Horsley et al., 2010, p. 21). Because reflection is intended for the individual, and professional development research has indicated that groups (i.e. coaching, PLCs) can strengthen learned skills, the term, "follow-up" was used in place of reflection.

Follow-up is "intended to strengthen the transfer of learned strategies or skills so they will be retained and applied effectively" (Christopher, 2008, p. 1). Follow-up through coaching can foster implantation of the curriculum and instructional strategies, reinforce knowledge already learned, and help boost teachers' self-efficacy (Neuman & Cunningham, 2009; Poglinco et al., 2003). Professional learning communities (PLCs) provided teachers with opportunities to reflect on strategies implemented in their classrooms and analyze data to identify student success. They had the capacity to create sustainable improvement (Hord, 2009; Stoll, Bolam, McMahon, Wallace, & Thomas, 2006).

Support

When learning a new skill, it can take up to 20 separate instances of practice to master, and during this time teachers need the most support (Gulamhussein, 2013; Joyce & Showers, 2002; Weiss, Heck, Pasley, Gordon, & Kannapel, 2010). For teachers to put into practice new knowledge and skills, support should be established through multiple sources: emotional, at the administrative level, and professionally. Teachers have to perceive that support is coming from their administrations; lack of perceived support could have a negative impact on classroom practice (Banilower, Heck, & Weiss, 2007). Support can be emotional -- expressed through commiserating with or receiving encouragement from other educators (Luehmann & Tinelli, 2008). Research has shown that professional support, like professional development programs, provided teachers with opportunities to interact with professionals in the field; this interaction influenced teachers' pedagogical knowledge and content knowledge (Hughes, Molyneaux, & Dixon, 2012).

Resources

Norton Grubb (2008) broke resources into four categories: simple, compound, complex, and abstract. Educational policies that provide monetary resources can be used to support teacher learning (Knapp & Plecki, 2001) through technology, community resources (such as museums, aquariums, and zoos), printable materials, instruments for labs, guest speakers, interactive websites, and others. These are simple resources -- tangible items. Compound resources, also tangible, combined education items, such as class size reduction and professional development, to improve teaching practice.

Examples of complex resources include teachers who are the same race as the students, or informal professional development. This has proven to have a moderate effect on student learning outcome (Dee, 2004; Little, 2006). Teachers' ability to relate to their students and identify what can be brought into the classroom are the intangible resources of professional development. Intangible resources include teachers' ability to relate to professional development content, as well as their ability to bring professional development back to the classroom. Research showed that when professional development was connected to what teachers were doing in the classroom, teaching practices were more likely to change, and this change was associated with student gains (Corcoran, McVay & Riordan, 2003; Darling-Hammond & McLaughlin, 2011).

Duration

Research indicated that the duration of the professional development positively impacted teacher change and student learning (Wei et al., 2009). For changes in classroom practice to occur, teachers must be exposed to at least 30 hours of professional development (Weiss & Pasley, 2007); more time spent in professional development (i.e. 80-100 hours) increased the likelihood of teachers using pedagogical strategies taught (Banilower, Heck, & Weiss, 2007; Desimone et al., 2002; Yoon et al., 2007). Teachers viewed effective professional development as sustained, and provided numbers of contact hours that afforded them "opportunities to engage in active learning, enable meaningful collaboration and focus on content" (Wei et al., 2009, p. 8). Professional development spread out over six to 12 months, ranging from 30 to 100 hours, produced lasting effects on student learning (Yoon et al., 2007).

Summary of Components

Table 2 provided a clear definition for each of the components selected for this study. These definitions were truncated and further summarized to be included on the survey. See Table 3 for survey definition of components.

Table 2

Definitions of Components

Component	Definition
Content knowledge	A rich understanding that is organized with relevant facts about concepts and principles of a specific domain (e.g. physics) (Shulman, 1986) and contains information about a core curricular course (STEM or non-STEM)[a].
Pedagogical knowledge	Are "ways of representing and formulating the subject that make it comprehensive to others" (Shulman, 1986, p. 9) by instructing teaching methods (i.e. scaffolding, inquiry based learning).
Active learning	Are opportunities of modeling new strategies (usually pedagogical methods) and allowing teachers to practice them.
Collaboration	Sharing effective instructional practices to help reshape teachers' views (Fazio, 2009; Nelson, 2009; Wei et al., 2009) and help teachers develop expertise in regards to common goals for student learning (Hill, Stumbo, Paliokas, Hansen, & McWalters, 2010).
Alignment with goals and policies	Described as the overall professional development design being part of a school or district based reform effort (Darling-Hammond & Richardson, 2009).
Follow-up	Reflect and consider the most important aspects for him/her (Loucks-Horsley et al., 2010). Foster implantation of the curriculum and instructional strategies, reinforce knowledge already learned, and help boost teachers' self-efficacy (Neuman & Cunningham, 2009; Poglinco et al., 2003) through coaching and PLCs.
Duration	Measured in hours and frequency spent in formally structured professional development workshops created by either the school or district. Formally structured meaning that it is implicitly stated/categorized/classified as professional development or professional growth.
Support	Emotional support defined as expressed through commiserating with and [receiving] encouragement from other educators and administrators (Banilower, Heck, & Weiss, 2007; Luehmann & Tinelli, 2008). Professional support occurs through the interactions with professionals in the field (Hughes et al., 2012).
Resources	Tangible resources are monetary resources used for teacher support (Knapp & Plecki, 2001) such as printed material, class size reductions, and professional development. One could define intangible resources as the connection between professional development and what teachers are doing in the classroom.

[a]Core curricular courses are STEM (science, technology, engineering, mathematics, and technology) and non-STEM (all other subjects) specified by Florida Department of Education as necessary for graduation or grade level advancement.

Science, Technology, Engineering, and Mathematics

The historical outcomes of the educational system in the United States has tailored legislation. This has, in turn, impacted specific subjects and professional development. The progression of education and the pieces of legislative policies that advanced education in the United States shed light on the creation of professional development for science, technology, engineering, and mathematics. As a result, the inclusion of science, technology, engineering, and mathematics in the United States' educational structure, and the creation of professional development for these subjects, have varied in the past, but are progressing in similar ways in the present.

Education

Education in the United States was a slow progression until the mid to late 1800s. What changed was the role schooling played in society, in terms of curriculum and methodology (Del Giorno, 1967). The Nation's welfare was dependent on the proper education of its citizens, which created great concern for the future (Mackenzie, 1894). Concerns for the Nation's educational system prompted the leading educational organization, National Education Association, to form the Committee of Ten in 1892. The Committee of Ten appointed conference committees for nine subjects: 1. Latin; 2. Greek; 3. English; 4. Other Modern Languages; 5. Mathematics; 6. Physics, Astronomy and Chemistry; 7. Natural History (included biology, botany, zoology, and physiology); 8. History, Civil Government and Political Economy; and 9. Geography (National Education Association, 1894). With these conference committees, the United States' educational system began to form a curriculum structure with defined subjects. The head of the committee, Charles Eliot, made two major recommendations: the earlier entry of

teaching subjects, and the provision of instruction in all subjects for both college-bound and non-college-bound students (National Education Association, 1894; Weidner, 2004). These changes created opportunities and a need for teachers to receive professional development, and inspired the emergence of science, technology, engineering, and mathematics within the core curriculum.

Society and federal education policies placed varying degrees of emphasis on different subjects at different points in time. As a result, starting in the early 1900s, STEM education was broken into science, technology, engineering, and mathematics education.

Science. Science education was not part of the United States' educational structure until the late 1800s. Prior to this time, education focused on literacy and numeracy. The convening of the Committee of Ten in 1892 was the turning point for science education's inclusion in the United States' educational course edifice. Science curriculum in the late 1800s varied from state to state, and even from school to school. The lack of uniformity in the curriculum was due, in large part, to a lack of federal policies pertaining to science education. In addition, scientists, not teachers, influenced the curriculum.

Entering the 20th century, science education began to drift away from personal, intellectual development and moved toward social relevance. This shift in ideology occurred because the United States' industry was almost fully developed, and factories needed a workforce that could help build and maintain them (Kelly, 2017). Also, the United States encountered Germany's advancements in weaponry during World War I (Sterling, 2008); many discoveries and investigations were occurring in the sciences

during this time. Further impacting science curriculum ideology was *The Cardinal Principals of Secondary Education*, which the National Educations Association created in 1918. The Cardinal Principals not only addressed subjects for science, but also tackled the structure of schools in regards to the division of secondary school into junior and senior high, and the subject taught at each grade level (National Education Association, 1918). According to Del Giorno (1967), a few studies from the Committee on Science Education (1928) and the National Society for the Study of Education (1932) indicated that schools were not following the Committee of Ten's recommendation on how to structure science courses; these courses needed to be reorganized. It would be another 20 years before science education received a major overhaul.

In 1950, the National Science Foundation Act was ratified, creating the National Science Foundation (NSF). The NSF was charged with the responsibility of science education and science teachers' professional development. In October of 1957, the American people watched as the Soviet Union successfully launched Sputnik I into space. The Federal government's response was to pass the National Defense Education Act (NDEA) of 1958. The NDEA was the most comprehensive educational policy passed to date, and its primary goal was to improve science, mathematics, and foreign language education (United States Senate, n.d.). This goal would be accomplished by exponentially increasing funds for primary and secondary education.

Several decades later, science education received further enhancements with the 1988 Augustus F. Hawkins-Robert T. Stafford Elementary and Secondary School Improvement Amendments. These amendments contained the Dwight D. Eisenhower Mathematics and Science Education Act, which had the purpose of strengthening

instruction in mathematics and science through the State educational agencies, local educational agencies, and institutes of higher education by creating programs geared toward science and mathematics education.

Science education continued to progress with the passing of the Excellence in Mathematics, Science and Engineering Education Act of 1990, promoting excellence in science education, and Goals 2000: Educate America Act. This created a platform for standard-development in science, as well as other subjects. Two years following this piece of legislation, the National Research Council published the *National Science Education Standards*. With these standards, along with funding from legislation, science education received major boosts in the 20th century; these enhancements have continued to grow.

Technology. Technology, as defined by Webster, is the practical application of knowledge with the use of technical process/method or knowledge to accomplish a task. This would make technology education the subject in schools that teaches the practical application of knowledge and technical processes and methods. This broad definition has come to illuminate multiple paths that technology education has taken over the years, from technical schools that are two-year colleges to vocational education, which prepares people to work as technicians in various trades. Today, the International Technology Education Association (2007) has defined technology and technology education. Arriving at this definition was not a clean, simple process.

Technology education had its debut in the 1800s with manual arts. The term, "manual" was described at the time as "what [was] employed by hand, of which an immediate profit [was] made" (Crabb, 1823, p. 188). Charles Richard was instrumental

in the transition of the term, “manual arts” to “industrial arts” because of the shift in definition (Dugger, 2016a). The authoritative definition most widely used was by Bonser and Mossman in *Industrial Arts for Elementary Schools* (1923).

As Bonser and Mossman’s definition took hold for the industrial arts, the manual arts definition was found in the United States educational system in the form of vocational education. This is an important point because during the early half of the 1900s, the Federal government provided major funding for vocational programs through policies like the Highs-Smith National Vocational Education Act of 1917. Though the Federal government had yet to provide financial assistance to create curriculum for technology education, it was still making a mark on K-12 public education. In cities like Cleveland, OH; Rochester, NY; Menomonie, WI; and others, industrial arts education could be found in the K-12 public education system.

Between the 1930s and the 1980s, there was a murkiness in differentiating the industrial arts and technology education within educational policies, making it difficult, but not impossible, to determine when the transition occurred from one to the other. This could be a result of how the term, “technology” is defined.

The term, “technology” became more commonly used in the United States after the Massachusetts Institute of Technology was founded in 1861. In the early 1900s, Thorstein Veblen provided a more concrete definition of technology, and today, that definition is used for technology education. Veblen described technology as the “state of industrial arts” -- knowledge as well as practice included -- which encompassed productive pursuits and “emphasized human agency, not the determining effects of the material force” (Schatzberg, 2006, p. 505). The major education policies in the 20th

century did not use the term, “industrial arts”; they used “technology” and “technological.” But industrial arts education was still found in almost every State’s education curriculum. At the Federal level, technology education, as defined by Bonser, Mossman, and Veblen, was stipulated in the NDEA with a reference to technology regarding correcting the “imbalances in our educational programs which have led to an insufficient proportion of our population educated in science, mathematics, and modern foreign languages and trained in technology” (§101). Technology education was viewed as something that could enhance these subjects not as subjects in and of itself. Along these same lines, the Elementary and Secondary Education Act (ESEA) of 1965 further defined technology education as an accessory to science, engineering, and mathematics. The ESEA (1965) referenced providing programs for “technological fields which require the understanding and application of basic engineering, scientific, or mathematical principles or knowledge” (§601).

Sometime in the 1980s, the title of industrial arts education transitioned from the term, “industrial art” to the term, “technology education.” The change was more than likely a result of *The Standards for Industrial Arts Programs* written in 1981, which were revised and retitled *Standards for Technology Education* in 1985 (Dugger, 2016a). The Excellence in Mathematics, Science, and Engineering Education Act of 1990 was very specific in the type of technology education it would provide funding for. If states wished to receive grants for technology education, the technologies had to be computer-based technologies. This shifted how the United States educational system offered technology education and created many computer courses in K-12 schools. By the late 1980s, the term, “technology” had become engrained in the tenets of the federal

education system, but it would be decades before technology education would be recognized as a subject -- not just a tool to enhance education.

A 2010 report by the Committee on Standards for K–12 Engineering Education expressed the lack of attention that the "T" and "E" in STEM had received historically. The America COMPETES Act of 2007 and America COMPETES Reauthorization Act of 2010 seemed to be the first federal education policies to pull technology and engineering out from under the umbrella of science, though this was not made very clear in the policies. The "T" in STEM was referred to in education as a tool to help improve or enhance the other subjects' curriculums, but not as a separate subject.

For technology education to be considered a major subject in its right, a clear definition, along with standards, was needed. The first standards for technology education, *Standards for Technological Literacy: Content for the Study of Technology*, were written in 2000. Along with these standards, clear definitions were provided for technology and technology education.

Engineering. Engineering education had a slow progression in the United States educational system. As the United States approached the Civil War, engineering programs declined or were eliminated from colleges and universities. Revitalization of engineering education occurred when The Morrill Act of 1862, also known as the Land Grant Act, was passed.

A report from the Engineering's Council for Professional Development -- currently known as the Accreditation Board for Engineering and Technology -- indicated its concerns about the curriculum and the gap between fundamental science and engineering instruction. Around the same time, the American Society for Engineering

Education released the *Report of the Committee on Evaluation of Engineering Education* or the *Grinter Report* (1955). The *Grinter Report* (1955) showed that a strong need for engineering education, solid objectives were crucial, and curriculum was necessary for high school engineering courses to prepare students for college. As the United States entered the end of the 20th century, engineering education and professional development for the teachers of this subject began its slow and steady integration into the K-12 educational system through science.

In 1990, the Excellence in Mathematics, Science, and Engineering Education Act (EMSEEA) was passed to "promote excellence in American mathematics, science and engineering education" (intro.). However, EMSEEA definition of science included engineering, and the trend of lumping engineering with science and mathematics continued. Engineering education did not receive much individual attention from the Federal government for the next ten years. The NSF's prediction of an American workforce that lacked sufficient engineers by the year 2000 was soon to come to fruition. This provided the stimulus the federal government needed to revisit engineering education and include stipulations in legislation that addressed engineering, which was separate from science and mathematics.

The Committee on Standards for K-12 Engineering Education provided several reasons as to why engineering had yet to develop K-12 standards. The Committee stated that engineering education was strongly connected to science, mathematics, and technology. The standards for engineering education were the same as the standards for these subjects. Thus, engineering education did not need its own. Another rationale was that K-12 engineering was still in its infancy, making it difficult for engineering

education to stand on its own (Committee on Standards for K–12 Engineering Education, 2010). However, engineering education was not without some direction.

With guidelines from the *Engineering Criteria (EC) 2000,* along with other resources provided by the NSF, K-12 educators have been able to create curriculum for the "E" in STEM. At this point, no Federal policy had mandated the creation of separate standards for engineering. However, before engineering could gather momentum as an individual subject, the Federal government began to focus on the integration of science, technology, engineering, and mathematics education.

Math. In the United States, mathematical education was revisited along with science and technology during the industrial movement in the 18th and 19th centuries. During the earlier half of this time period, society focused on providing only the elite with mathematics education. But simple arithmetic and the ability to count money, to tell time, and to count units were all necessary for the average citizen. These skills needed to be taught which provided the shifted from a discipline reserved for a small, privileged sect of society to a discipline taught to the masses.

Post-World War II, the Federal government took an interest in mathematics education. This was a result of reports that indicated there were high numbers of soldiers entering the military who lacked basic mathematical skills and had to learn these skills (National Council of Teachers of Mathematics, 1944). The *Post War Plans* included rhetoric stating that the poor quality of teachers is what led to high numbers of uneducated soldiers. The National Council of Teachers of Mathematics (1944) suggested that the government address this by offering professional courses to help improve instructional skills. The *Guidance Report of the Commission on Post-War Plans,*

released in 1947, tackled the quality of high school mathematics, recommended that guidance counselors place students in mathematics courses, and suggested what mathematics courses to offer at school sites (Center for the Study of Mathematics Curriculum, 2004). These comprehensive reports showed the benefits of mathematics education and its applications in everyday life. Despite the fact that the military complained about the exorbitant expense of educating the soldiers in basic mathematics and the benefits the reports pointed out, the Federal government required more to write educational policy that focused on mathematics education and professional development for mathematics teachers.

Two major educational policies, National Defense Education Act and Elementary and Secondary Education Act (ESEA), concentrated on higher education mathematics rather than K-12 mathematics curriculum or teacher professional development. Mathematics education at the K-12 level finally received emphasis in the 1978 amendments of ESEA, which authorized the Secretary to make grants to agencies, institutions, or organizations for special programs for the teaching of standard mathematics. Prior to 1988, federal policy classified mathematics, along with reading, writing, and oral communication, as a basic skill. In 1988, the Augustus F. Hawkins-Robert Stafford Elementary and Secondary School Improvement Amendments labeled mathematics a "critical skill."

Mathematics education was now firmly entrenched in the K-12 educational structure. Moving forward, the Federal government took a global prospective on mathematics education to help improve the Nation. The Excellence in Mathematics, Science, and Engineering Education Act of 1990 (EMSEEA) found that "science and

mathematics [were] cornerstones of America's efforts to compete in the global marketplace" (§101). Continuing with this global mindset, No Child Left Behind (NCLB) mandated that all States have academic standards for all public schools and an assessment created to measure student growth -- at least in mathematics -- by the 2005-2006 school year. *The National Assessment of Educational Progress* or 'The Nation's Report Card' measured the progress that EMSEEA and NLCB made from 1990 to 2007. This indicated fourth graders' 27 point growth and eight graders' 19 point growth on the mathematics portion of the assessment (National Science Board, 2010). Carrying on the enhancement of mathematics education at the Federal level, the America COMPETES Act of 2007 contained a section entitled *Math Now for Elementary School and Middle School Student Programs* with the purpose of enabling all students to reach or exceed grade-level academic achievement through improving instruction and providing funds (§6201). Mathematics education may have begun in the United States as an elitist course, but it has morphed into a core subject and is very prominent in educational policies.

STEM. A buzz term, "STEM," began to emerge among policy writers and education professionals to describe the professional development and education that encompassed science, technology, engineering, and mathematics. The term "STEM" (science, technology, engineering, and mathematics) was coined by the National Science Foundation sometime in the early 1990s (Dugger, 2016b). Even though "STEM" included engineering and technology, when the acronym was used, it most often referred to mathematics and science. This could be because of how past federal policy defined science as including engineering, and technology, in many instances, was described as a tool used in education rather than a subject. In 2010, the term, "STEM" appeared in a

federal policy, and was defined as "the academic and professional disciplines of science, technology, engineering, and mathematics" (America COMPETES Reauthorization Act, 2010, §2).

The America Creating Opportunities to Meaningfully Promote Excellence in Technology, Education, and Science Act of 2007 or America COMPETES contained a section titled "National Panel on Promising Practices in K-12 STEM Teaching and Learning," which was tasked with "identifying promising practices for improving teaching and student achievement in science, technology, engineering, and mathematics" (§6131). Technology and engineering, for what seemed like the first time in a federal educational policy, were treated as separate subjects, and the acronym STEM was used. It is not until the Act was reauthorized in 2010 (as the America COMPETES Reauthorization Act) that STEM was defined. Though STEM was used liberally throughout the America COMPETES Reauthorization Act, it was not for the purpose of STEM education, which would later be described as an integration of the individual subjects. It was used as an abbreviation for each subject.

The America COMPETES Reauthorization Act of 2010 brought about more changes to STEM education, and much was done through a section entitled *Science, Technology, Engineering, and Mathematics Support Programs*. This housed the National Science Foundation Authorization Act of 2010, which made $9.3785 billion available to be used for education and human resources at the National Science Foundation (§503). The allotment of funds to the National Science Foundation (NSF) was important to STEM education because in 2012, an analysis of Federal funds revealed that the majority of STEM education funding and professional development came from the NSF. This

analysis stated that the NSF was a "key component of the federal STEM education effort" (Gonzalez, 2012, p. 1).

In order to practice the integration of STEM, educators fashioned curriculum by using the standards set forth by the "National Council of Teachers of Mathematics' Principles and Standards for School Mathematics (2000), the National Research Council's National Science Education Standards (1996), Standards for Technological Literacy (2000), the Accreditation Board for Engineering and Technology's Engineering Criteria 2000 (1997), and the Common Core State Standards Initiative for Mathematics (2011)" (Asunda, 2012, para. 16).

The most recent educational policy, Every Student Succeeds Act, used the acronym STEM in several places throughout the policy. One was under the "well-rounded educational opportunities" that directed local education agencies to use funds to create programs and activities for science, technology, engineering, and mathematics. These subjects were referred to as 'STEM subjects' (§4107). The ESSA contained a section for "STEM Master Teacher Corps," which were "State-led effort[s] to elevate the status of the science, technology, engineering, and mathematics teaching profession" (§2245). Another use of the acronym described what a "STEM-focused Specialty School" was:

> a school, or dedicated program within a school that engages students in rigorous, relevant, and integrated learning experiences focused on science, technology, engineering, and mathematics, including computer science, which include authentic school wide research (§4102).

Though this was not a clearly defined integration of the subjects, science, technology, engineering, and mathematics, it was a start, and provided a platform for future policies that addressed STEM education.

Professional Development

In the latter part of the 19th century, professional development became a great concern with the emergence of textbooks that questioned teaching methodology. These textbooks addressed specific teaching methods, like not using the textbook alone, and allowing the student to discover things on his/her own (Del Giorno, 1967). During this time, teachers received professional development by reading magazines (such as *Science)*, books, and letters (like the *Preston Papers*), field experience, and/or trainings (such as those offered to manual arts instructors by the Industrial Education Association). This created unstructured professional development, or professional development that occurred without financial assistance from the federal government.

The history of professional development -- whether for science, technology, engineering, mathematics, or other subjects -- must be viewed through the lens of educational policy, curriculum, and tools for education. Taking this approach makes it easier to see the transition of professional development from unstructured, which still takes place today, to structured, as mandated by federal and state policies.

To accurately describe professional development, several definitions must be combined: First, professional development is the ongoing learning experience of a teacher (Luft & Hewson, 2014). Christopher Day's (1999) definition of professional development is all-natural learning experiences and planned activities intended to directly or indirectly benefit the individual or school. Through these activities, teachers "renew

and extend their commitment as change agents" (Day, 1999, p. 18). If one blended these definitions, he/she might then define professional development as a continuous learning experience that has a direct and indirect impact on the teacher and the teacher's commitment as a change agent in his or her classroom. Using this definition, one can map out professional development for science, technology, engineering, and mathematics education both informally and formally at the state and federal level.

Formally structured professional development for a science, technology, engineering, or mathematics subject did not appear in federal policy until the 1978 amendments of the Elementary and Secondary Education Act. Previous acts had stipulations for professional development, but did not specifically state that professional development was necessary for mathematics, engineering, technology, or science. The Dwight D. Eisenhower Mathematics and Science Education Act of 1988 offered proviso for mathematics and science teacher professional development. In addition, the Eisenhower Math and Science Education Program grew out of this legislation. The purpose of this program was to improve mathematics and science education through the recruitment and training of high quality teachers, which would thus improve the nation's security and economic standing.

The Excellence in Mathematics, Science, and Engineering Education Act of 1990 (EMSEEA) provided grants for Science-Technology Centers, which were publicly accessible locations, such as museums, planetariums, libraries, and zoos. At first glance, these locations appeared to offer only science and technology programs, but, EMSEEA defined the term, "science" to include "mathematics, and engineering" (§231). Therefore, these centers were awarded funds to help develop "educational activities, such

as curriculum development, teacher training programs, and student educational kits" for engineering, science, technology, and mathematics (EMSEEA, 1990, §231). Though professional development for science, technology, engineering, and mathematics was receiving funding from the federal government and morphing into a more structured program, it still was not meeting teachers' needs.

The *Progress Through the Teacher Pipeline: 1992–93 College Graduates and Elementary/Secondary School Teaching as of 1997* acknowledged research that indicated K-12 teacher professional development was "viewed as inadequate by many scholars and policymakers, and initiatives to improve [were abundant]" (Henke, Chen, & Geis, 2000, p. 2). A core argument was that formal professional development would not have lasting effects unless it was connected to the classroom (Fullen & Stiegelbauer, 1991). The National Center for Education Statistics (2001) found that only 18 percent of public school teachers felt that professional development was linked to their classrooms. It was also proposed that teachers were more likely to participate in professional development that focused on state or district curriculum and performance standards (80 percent), while 74 percent preferred integration of educational technology trainings, and 72 percent preferred an "in-depth study of the subject area of the main teaching assignment" (Parsad, Lewis, Farris, & Westat, 2001, p. 4). A study for mathematics and science education indicated that teachers felt they needed the most professional development in the use of technology in the classroom. Teachers felt that they needed the second most professional development in content knowledge -- mathematics and science content for elementary teachers and science content only for middle school teachers; high school teachers were not concerned with their content knowledge (Weiss, Banilower, McMahon, & Smith,

2001). The findings in these studies as well as several others prompted policy writers to include provisions for professional development in the rewrite of the Elementary and Secondary Education Act, No Child Left Behind.

The No Child Left Behind Act of 2001 (NCLB) not only included improvements for professional development and stipulations for stronger accountability, but also contained initiatives to help revitalize STEM education (United States Department of Education, 2012). The NCLB allowed funds to be combined from Title II -- "Preparing, training, and recruiting high quality teachers and principals" -- with this Act, other Acts, and other sources for professional development (§1119). It specified that there should be,

> (2) [a] focus on the education of mathematics and science teachers… [that development] continuously stimulate teachers' intellectual growth and upgrade teachers' knowledge and skills… (3) bring mathematics and science teachers… together with scientists, mathematicians, and engineers to increase the subject matter knowledge of mathematics and science teachers… (5) [and] improve and expand training of mathematics and science teachers… in effective integration of technology (§2201).

The NCLB's focus for professional development was on science and mathematics. Engineering contained within the field of science as it had been in the past, and technology education was viewed in the same manner as it had been in previous educational policies -- as a tool to enhance education. The focus on mathematics and science education professional development was further established in NCLB with provisions to grow partnerships with mathematics and science educational agencies outside of the classroom.

The Mathematics and Science Partnerships (MSPs) had a goal to improve students' academic achievement in mathematics and science through the teachers who would partake in the program. The MSPs purposes were to encourage higher institutes to improve teacher education for mathematics and science teachers by "Focus[ing] on the education of mathematics and science teachers as a career-long process that continuously stimulate[d] teachers' intellectual growth and upgrade[d] teachers' knowledge and skills" (No Child Left Behind, 2002, §2201). The MSPs formed to bring together educators and professionals in mathematics and sciences and improve their teaching skills by exposing them to sophisticated laboratory equipment and other resources. The overall goals for the MSPs were that teachers develop curriculum that align with the state's standards, and that educators enforce the "standards expected for postsecondary study in engineering, mathematics, and science" within classrooms (No Child Left Behind, 2002, §2201). To fulfill NCLB requirements, states were mandated to create assessments and curriculum that aligned with standards. The assessments showed the long-term trend in reading and mathematics for students, and created an avenue for improving professional development.

Education Week's 2005 *Quality Counts* report disclosed that states were implementing policies that helped them meet the directives of NCLB. By 2004, all states had professional development requirements for license renewal that varied in criteria from superintendent recommendations to 150 hours of professional development (Cavell, Blank, Toye, & Williams, 2004). Thirty-seven states had funds specifically for professional development programs, 24 states established policies that aligned professional development with state content standards, and 35 had standards in place for professional development (Cavell, Blank, Toye, & Williams, 2004; Skinner, 2005). The

state's initiatives for professional development created an increase in teacher participation, but "most teachers' professional development experiences were not of high quality" (National Science Board, 2006, p. 1-41). In 2007, *Rising Above the Gathering Storm* stated that teachers were the key to improving student performance, which influenced the government to place a stronger emphasis on STEM education and professional development in the next federal policy.

In *Rising Above the Gathering Storm* (2007), the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine formed a committee. This committee voiced its concerns regarding the erosion of the scientific and technological building blocks that were needed to maintain the United States' economic leadership. The report identified two key challenges connected to STEM skills: the creation of high-quality jobs for Americans, and the nation's need for affordable, clean, and reliable energy. The committee recommended four actions U.S. citizens could take to overcome these challenges. One of these actions called for changes in K-12 education: *10,000 Teachers, 10 Million Minds* (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007). The report acknowledged a teacher shortage, and that students had only a 40 percent chance of having a teacher for chemistry who majored in the subject. On the other hand, for English, students had an 80 percent chance of having a teacher who majored in the subject (National Academy of Sciences, National Academy of Engineering, and Institute of Medicine, 2007). *Rising Above the Gathering Storm* (2007) specified a need for professional development opportunities that were high-quality, focused on content, had a significant effect on student performance, included year-long mentoring, contained pedagogical strategies, and provided high-

quality curricular materials. To tackle the goal of *10,000 Teachers, 10 Million Minds*, federal policymakers drafted a bill to provide resources for the enhancement of STEM education and professional development.

The America COMPETES Act of 2007 was, "an Act to invest in innovation through research and development, and to improve the competitiveness of the United States" (intro.). The America COMPETES Act Title VI was devoted to education and allotted grants for teachers to earn master's degrees in science, technology, engineering, and mathematics education. The America COMPETES Act authorized programs for teachers to participate in research and created other professional development opportunities to enhance teachers' science, technology, engineering, and mathematics content knowledge.

In December 2007, America's economy began to show signs of instability. The federal government signed the American Recovery and Reinvestment Act of 2009 (ARRA) to avert education cuts (United States Department of Education, 2009a). The ARRA encompassed $4.35 billion in funds for a competitive grant program called, 'Race to the Top.' A criterion on the application required states to include plans for high-quality professional development; priority was given to applications that were STEM-focused (United States Department of Education, 2009b). The monetary investments from ARRA and 'Race to the Top' provided education with the means to continue to move forward. Overall, the nation was making progress (based on the Nation's Report Card 1990-2007 and the Trends in International Mathematics and Science Study or TIMSS 1995 and 2007 report). In 2010, the government reauthorized the America COMPETES Act to continue the growth of STEM education.

In America COMPETES Reauthorization Act of 2010, there were many provisions for improvement in education and professional development for science, technology, engineering, and mathematics. Under the direction of the Office of Science and Technology Policy, a committee called CoSTEM was established to coordinate Federal STEM education and STEM programs (§101). CoSTEM was tasked with creating a five-year strategic plan that pledged money for recruiting high-quality STEM teachers, producing high-quality professional development, strengthening the infrastructure for supporting STEM instruction and engagement, and providing STEM with resources and equipment (National Science and Technology Council Committee on STEM Education, 2011).

In 2015, after much debate and many amendments, the Elementary and Secondary Education Act was reauthorized as Every Student Succeeds Act (ESSA). The Nation's commitment to equal opportunity for all students was renewed and included STEM education and professional development, but not to the extent proposed in the first drafts. The ESSA required the integration of engineering design skills and practices into the states' science assessments (§1201). States were expected to carry out programs that provided alternative routes for state certification, "especially for teachers of… science, technology, engineering, mathematics" (§2101). The ESSA made states and local agencies responsible for developing and providing professional development for teachers to promote high-quality instruction in science, technology, engineering, mathematics, and computer science (§2101, §2103). The ESSA allotted grants for STEM partnerships, which would replace the MSPs that were no longer being funded. They mandated that

teachers be provided professional development regarding the effective use of technology to enhance student achievement in STEM areas, including computer science (§4109).

Teacher professional development for science, technology, engineering, and mathematics has transitioned from unstructured to structured with the help of federal educational policies that had provided funds. Though much unstructured professional development still exists, teachers are now able to receive formal trainings to help them grow in their content knowledge and pedagogy to disseminate this knowledge to their students.

Current Status

In the early 21st century, educational programs for students, as well as professional development workshops that science, technology, engineering, and mathematics teachers attended, changed significantly. Several policies that had major ramifications for these subjects' curriculum, standards, and professional development were passed. The "T" and "E" in STEM began to assert themselves and create their own identities, separate from mathematics and science.

The NCLB was a comprehensive bill that brought accountability to education and stressed the need for interactions between America's STEM businesses and STEM education. The America COMPETES Act of 2007 placed heavy emphasis on STEM education and STEM teacher recruitment. Both the America COMPETES Act of 2007 and the America COMPETES Reauthorization Act of 2010 stipulated provisions to strengthen teaching and learning in the primary and secondary levels of STEM education. In addition, they provided funding to the National Science Foundation for professional

growth trainings, program and curriculum development, and standards geared toward the integration of science, technology, engineering, and mathematics.

The ESSA created a foundation for STEM education and its integration. The "T" in STEM is currently much stronger. Technology is now an elective area in most states and has over 28,000 teachers (Dugger, 2016a). The "E" in STEM is slowly progressing; there have been some promising developments. In *Framework for Quality K-12 Engineering Education*, authors, Moore et al. (2014) proposed a clear definition for K-12 engineering education programs. These advances in engineering education will help guide policy-makers and educators in the creation of curriculum and standards for engineering, and in the integration of engineering in STEM.

Even though ESSA did not define STEM in terms of curriculum and standard-integration, it did contain provisions to form programs and professional development models that were STEM-based, and for each STEM subject. No longer the acronym, STEM place emphasis on science and/or mathematics alone. People now address each content area in the acronym individually. When one uses the acronym, he/she is referring to an integration of the subjects. STEM education continues to advance, and STEM educators will receive the training and support to help nurture the nation's aspiring scientists, technologists, engineers, and mathematicians.

Title I

The federal government provides financial assistance to schools that meet the criteria that the Part A (Title I) of the Elementary and Secondary Education Act set. Schools identified as Title I have a high percentage of students who come from economically disadvantaged families (United States Department of Education, 2015a).

Schools that receive Title I funds must devote sufficient resources, effectively carrying out high quality and ongoing professional development for teachers (Elementary and Secondary Education Act, 1965). In the state of Florida, Title I classification provides additional teachers, professional development, extra time for teaching, parent involvement activities, and other activities designed to raise student achievement at designated schools (Florida Department of Education, n.d.).

Title I Professional Development

A preliminary search for Title I needs revealed that the majority of U.S. states have some form of needs assessment that schools and parents must complete. California's Department of Education's (2015) website stated that "adopting this strategy should result in an ongoing, comprehensive plan for school improvement that is owned by the entire school community and tailored to its unique needs" (para. 3). Research for Title I and professional development is limited, but there are key studies that have provided meaningful conclusions (Yettick, 2015).

The National Institute of Education's *Compensatory Education Study* (1978) showed that districts are using "soft-money of Title I" to "recruit and select well-qualified teachers and provide them with numerous opportunities for professional development" (p. 76). A 1982 study on elementary education identified instructional practices that effectively raised reading and math achievements of economically disadvantaged students (Carter, 1984). The *Congressionally Mandated Study of Educational Growth and Opportunity* (1993) showed that services varied considerably by district and by school, and stated that elementary teachers at Title I and non-Title I schools received the same average number of hours of professional development per

year: 24 hours. The cohort of seventh grade math and English teachers at a low-poverty school, on the other hand, "received an average of 15 to 20 percent more hours of staff development in the last year (4 hours more per year) than the teachers of students in high-poverty schools" (Puma et al., 1993, p. 272). The Westat and Policy Studies Associates' 2001 study *Longitudinal Evaluation of School Change and Performance* reported that the students of high school teachers who rated professional development favorably showed more gains on SAT-9 than the students of teachers who did not.

A 2011 report *High-Quality Professional Development for All Teachers: Effectively Allocating Resources* found that schools with higher numbers of poor students were more likely to be assigned teachers with less experience. Teachers' experiences affect their ability to generate high levels of student learning; this impacts student achievement (Clotfelter, Ladd, & Vigdor, 2007). Though not highly studied, research has indicated that a school's Title I status affects teacher-quality and student achievement. There is no research on whether teachers benefit from receiving professional development tailored to the specific needs of Title I schools. There is, thus, an opportunity to conduct some research on this topic.

Grade Levels of Instruction

The structure of the United States' educational system today emerged in 1848. Horace Mann, who used the Persian model of the common school to place students into grades by age, established this structure. It was revolutionary at the time, when one-room school houses that instructed students of various ages were the norm (Peterson, 2010). Over the past several decades, research looking at the neurological and learning development of children has supported the K-12 educational structure.

Elementary, Middle, and High

A large supporter of grade-level division within public education was Francis Parker (1837-1902), who was influenced by Herbart and Froebel's philosophies of child development (Del Goirno, 1967). Friedrich Wilhelm August Fröbel or Froebel (1782-1852) coined the term, "kindergarten" and felt that education should recognize that children at various ages had unique capabilities and needs (Blyth, 1981). Francis Parker redirected elementary instruction. Like Froebel, he believed in children's unique needs, and in the individual development of students (Blyth, 1981). Charles Eliot (1834-1926) thought that grammar school should be shortened and enriched, leading to the junior high school movement. In regards to when to offer specific courses, the Committee of Ten pointed out that primary and grammar school should last at least eight years, and high school should last four (National Education Association, 1894).

The division of education into grade levels is not stipulated in any one piece of federal legislation, so there is no exact date when the United States' educational structure broke into elementary, middle, and high school. What is known is that grade levels in education resulted from a variety of federal, state, and local laws, along with court decisions adopted by educational institutions (International Affairs Office, U.S. Department of Education, 2008a). States determine the age that children must start attending school; most mandate attendance from age five or six through the age of 16 to 18 (Corsi-Bunker, n.d.). The grade-level structure track for education in the United States today begins with early childhood education (PreK), followed by primary or elementary school (comprised of grades kindergarten to fifth or sixth grade, depending on state or local legislation). Students then enter middle school (from sixth or seventh to

eighth grade). The final level of education is high school -- grades nine through twelve. Students can exit the school system as young as 16 years of age in some states. Figure 1 breaks down the ages and the grade levels associated with them. If the student desires, he or she can continue his/her education by attending postsecondary school at a university, college, or technical school (International Affairs Office, U.S. Department of Education, 2008b).

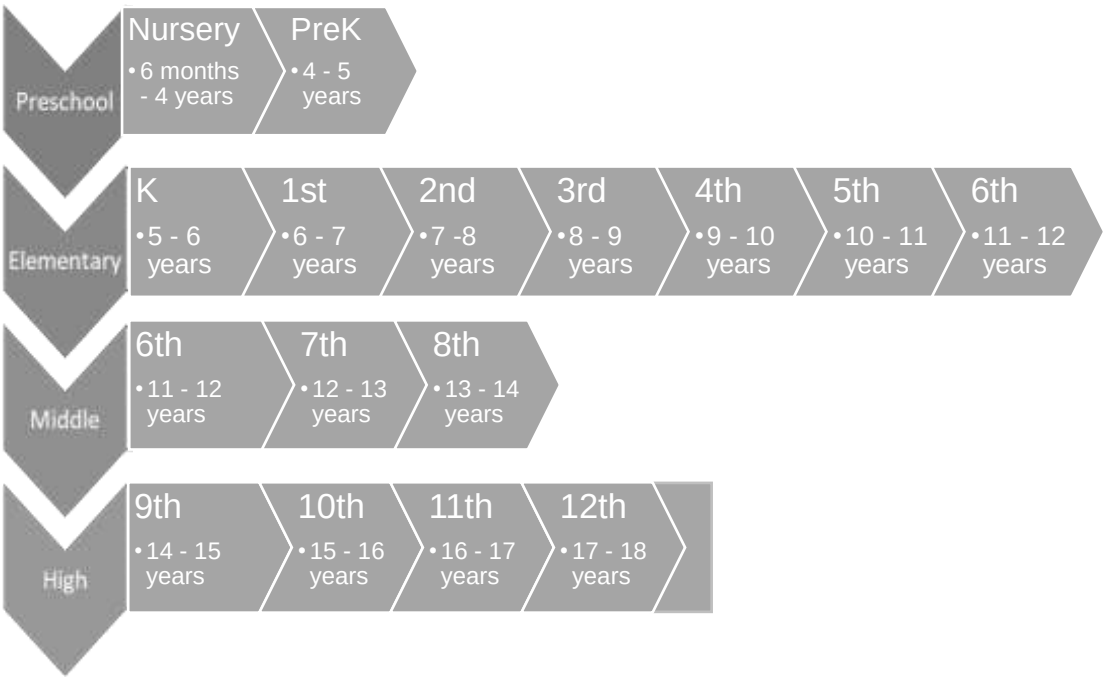

Figure 1. Progression of education by grade level and age.

Though most states still divide students based on age, there is a growing movement for competency-based education, also known as mastery-based, proficiency-based, and performance-based education. In competency-based education, students advance based on their levels of knowledge and skill, rather than time spent in the classroom (Strategy Labs, 2017). The district that the study was conducted within still implements the age-based, grade-level division of students.

Biological Development

Johann Friedrich Herbart (1776-1841) believed that a connection between individual development and societal contribution existed. He pointed out there was a unique quality to each child's mental development, and postulated a set of five practical ideas as a developmental sequence for the moral education of the child. Moral development had to be grounded in intellectual education, which Herbart termed, "Discipline and Instruction." Educators had to deliver the various phases of Discipline and Instruction in a specific sequence in order for the child to contribute to society in a meaningful way (Blyth, 1981). The advancements in science technology allowed scientists to investigate how the human brain developed over time, and provided research that further solidified the benefits of grade levels and delivering instruction through different methods for each student.

Several factors -- age, level of development and brain maturity, genetics, and environment -- influence the way children learn. The developing brain in an early elementary child is forming neural networks, making learning mostly rote in nature. Students who are eight to 14 years of age have increased connectivity within the neural network, and have more pathways that support short and long-term memory. The fact that the brain develops this way has allowed schools to emphasize inferential thinking, and deemphasize rote learning (Semrud-Clikeman, n.d.). Research on brain development has provided further evidence that the age-divided, grade-level structure for education is a valid model.

A central tenet of modern learning theories is that "different kinds of learning goals require different approaches to instruction" (The National Academies, 2000, p.

131). Various grade levels have different learning goals, thus creating the need for different approaches to instruction. Neurological research can be used to justify why teachers require professional development tailored to their grade level, and has led to the development of pedagogical strategies that vary according to the age group of students.

Differentiated instruction

Research has shown the need to group students in grade levels based on age and rate of cognitive development. This method of classroom organization/teaching, described by Carol Tomlinson (1999) as "Differentiated Instruction," provides students with multiple options to take in the information presented. Differentiated Instruction ensures that regardless of the instructional setting or the age of the student, he or she will learn something.

Differentiated Instruction's "primary goal is ensuring that teachers focus on processes and procedures that ensure effective learning for varied individuals" (Tomlinson & McTighe, 2006, p. 3). Tomlinson points out that an important aspect of Differentiated Instruction is the three curricular elements: 1. "Content-Input: What students learn, 2. Process: How students go about making sense of the ideas and information, and 3. Product-Output: How students demonstrate what they have learned" (Tomlinson, 2001, p. 4). When Tomlinson looked at the structure of an effective professional development design, she observed some important aspects of Differentiated Instruction. Effective professional development designs contain content and some processing, and request products from teachers. Overall, professional development seems to use the same programs for everyone, as opposed to modifying based on the audience. Therefore, professional development is not structured in the style of

differentiated instruction. The designs do not provide different learning options for those participating in professional development. The majority of teachers have expressed dissatisfaction of professional development's lack of relatability, or classroom-relevance which Differentiated Instruction calls for (Tomlinson, 2001). In order for professional development to be effective, creators of professional development must move away from the one-size-fits-all mentality, and move toward a mindset that is more like a differentiated classroom – one in which "the teacher proactively plans and carries out varied approaches to content, process, and product in anticipation of and response to student differences in readiness, interest, and learning needs" (Tomlinson, 2001, p. 7). Educational philosophy and neurophysiology research has validated grade-level instruction, since there are significant differences in students' levels of cognitive development, depending on age.

Chapter Summary

Each section of the literature was selected to provide a foundation for this study. The first section informed readers about the existing research on the effective components available to construct professional development designs. The second section reviewed science, technology, engineering, and mathematics education and professional development for these subjects using federal policies, curriculum, and standards. Also, readers learned about the evolution of STEM education and professional development, and how federal policies shaped our current understanding of the integration of science, technology, engineering, and mathematics (STEM). Readers also learned about various opportunities to enhance many of the STEM professional development programs. The third section examined research regarding schools that receive Title I funds and the

impact that Title I status has on professional development offerings and student achievement. The last section investigated the breakdown of grade levels in the United States, how neurophysiological research has helped reinforce the need for these grade levels, and how this translates into different instructional requirements in the classroom. This has resulted in a need for Differentiated Instruction in professional development.

Teachers must receive training that specifically addresses their needs according to subject area, Title I status of the school, or grade level of instruction. This can occur through an effectively designed professional development.

III. METHODOLOGY

The study proposed that one-size-fits-all professional development was not meeting the needs of the targeted audience and selected an embedded mixed method, with an overall quantitative design embedded with a qualitative method, to investigate the lack of differentiation found in professional development. The researcher employed an embedded mixed method design and permitted for the collection of two data sets -- one not being sufficient -- to determine if teachers' preferences regarding components included in an effective professional development design were influenced by subject taught, Title I status of the school, and grade level of instruction.

These factors created three independent variables to be examined: subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high). The independent variables paralleled the Community of Practice Theory, which is "a set of relations among persons, activity, and world, over time an in relation with other tangential and overlapping communities of practice" (Lave & Wenger, 1991, p. 98). The theoretical framework of a community of practice has guided the design choice because a causal-comparative design looks to see if the independent variable was influenced by the outcome. In addition, it determines differences that already exist between and among groups of individuals (Brewer & Kuhn, 2010; Fraenkel, Wallen, & Hyun, 2012).

The qualitative data identified if the components that the researcher chose aligned with the change that the targeted group perceived as part of an effective professional

development design. Key factors in Lewin's Three Step Change Theory are identifying issues in the status quo and including the change-targeted group (Burnes, 2012). The interview question structure allowed the researcher to first identify the inertia that existed in the professional development offered to K-12 teachers at a large public school district located in southeastern United States. The last question of the interview enhanced the overall quantitative design of the study by checking to see if the components that the researcher chose were ones that the change-targeted group perceived as part of an effective professional development design. The interviews not only included the change-target group, but also provided an opportunity for the researcher to tweak the nine components chosen if they did not align with what teachers perceived. This enhanced the quantitative design by providing reliability for the survey that was constructed using three theoretical models for professional development: Professional Development Framework (Loucks-Horsley et al., 2010), Practiced Based Theory (Ball & Cohen, 1999), and High-Quality Professional Development: Content, Context, and Design (Darling-Hammond & Richardson, 2009).

Researcher Role

The role of the researcher was to have the theoretical framework and research questions foremost in mind when conducting the interviews and distributing the survey. The researcher tried to identify any and all possible biases that might have shaped interpretations of the data. To minimize bias connected to the researcher's background in science, teachers that did not teach a STEM subject were included in the study. The researcher is currently employed with the district where the study was conducted, having the potential to create the "backyard" effect. "Backyard" occurs when the researcher is

studying the environment that he or she works in; this could lead to an imbalance of power between the participants and the researcher (Glense & Peshkin, 1997; as cited in Creswell, 2014). To eliminate "backyard," the researcher did not request school names on the survey.

Research Design

The researcher chose an Embedded Mixed Method Design as described by Creswell and Plano Clark (2011), with an overall casual-comparative design embedded with interviews, for this study. The use of a mixed method allowed for variation in data collection (leading to greater validity), identified possible variables, and could convey a group's needs (Bulsara, 2013; Hanson, Creswell, Plano Clark, Petska, & Creswell, 2005; Mertens, 2003; Punch, 1998). The interviews, a qualitative method, provided reliability for the components included in the survey by investigating if teachers' perceptions of components aligned with the nine the researcher selected. The quantitative method, survey, allowed for the researcher to investigate the impact of the variables on teachers' preferences for components included in the design (Creswell, 2013). For these reasons, this study used an embedded mixed method design to investigate if subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influenced the components teachers preferred in an effective professional development design.

Research Questions

The researcher set out to understand if subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction

(elementary, middle, high) influenced teachers' preferences for components included in an effective professional development design.

Research question 1: What are perceptions of effective professional development design components among K-12 school teachers in a large public-school district located in the southeastern part of the United States?

Research question 2: Do factors such as subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, high) influence teachers' preferences regarding the components included in an effective professional development design?

Research question 2a (2a): Does subject taught (STEM and non-STEM) influence preferences regarding components that should be included in an effective professional development design?

Null hypothesis 2a ($N_0$2a): Subject taught (STEM versus non-STEM) influences preferences regarding components included in an effective professional development design significantly.

Alternative hypothesis 2a (N2a): Subject taught (STEM versus non-STEM) does not influence preferences regarding components included in an effective professional development design significantly.

Research question 2b (2b): What are the differences, regarding preferences for components that should be included in an effective professional development design, between the teachers at Title I schools and teachers at non-Title I schools?

Null hypothesis 2b ($N_0$2b): Title I status of the school (Title I versus non-Title I) influences components included in an effective professional development design significantly.

Alternative hypothesis 2b (N2b): Title I status of the school (Title I versus non-Title I) does not influence components included in an effective professional development design significantly.

Research question 2c (2c): What are primary and secondary teachers' preferences regarding which components are part of effective professional development design?

Null hypothesis 2c ($N_0$2c): Grade level of instruction (elementary, middle, high) influences components included in an effective professional development design significantly.

Alternative hypothesis 2c (N2c): Grade level of instruction (elementary, middle, high) does not influence components included in an effective professional development significantly.

Research question 2d (2d): Are the differences in the components of the professional development design between STEM and non-STEM teachers a function of the Title I status of the school (Title I and non-Title I)?

Null hypothesis 2d ($N_0$2d): The difference between STEM and non-STEM teachers' preferences of components included in an effective professional development design is a significant function of Title I status of the school (Title I and non-Title I).

Alternative hypothesis 2d (N2d): The difference between STEM and non-STEM teachers' preferences components included in an effective

professional development design is not a significant function of Title I status of the school (Title I and non-Title I).

Sampling Design

Site

The purposefully selected site for the research study was a large public-school district located in southeastern United States. The size of the district made it a favorable site to conduct research. The study conducted research at 153 schools (77 schools classified as Title I); the remaining 27 schools did not meet the researcher's criteria in terms of not classified as charter schools, ESE sites, or Alternative sites. To gain access to the various school sites, the researcher obtained permission from the district and the university's Internal Review Board (IRB). The researcher submitted a thorough application that included consent form, interview protocol, and survey protocol to the IRB. Once the IRB approved it, the researcher sent it to the district for additional approval.

From the list of 153 schools, 12 were selected (based on highest student enrollment) to garner candidates for interviews. Student enrollment determines instructional staff; larger school sites have more teachers, increasing the probability of finding interview candidates that have a depth of knowledge regarding professional development. For these reasons, the researcher selected the two elementary Title I schools with the highest student populations, the two elementary non-Title I schools with the highest student populations, the two middle Title I schools with the highest student populations, the two middle non-Title I schools with the highest student populations, the two high Title I schools with the highest student populations, and the two high non-Title I

schools with the highest student populations for this study. The researcher then solicited participants for interviews and administered the survey to all teachers at the 153 schools that met her criteria (not classified as charter schools, ESE sites, or Alternative sites). According to district policy, professional development must occur in all the schools, regardless of Title I status and grade level of instruction.

Population

The targeted population for this research study were instructional staff employed with the large public school district located in southeastern United States. These participants included teachers who instructed students in grades kindergarten through twelve, and partook in at least one professional development that the district or the school provided. Teachers who are in the classroom may be more cognizant of their needs for professional development, and are more likely to have participated in at least one professional development that the district or school provided. Each school site's professional development team receives training from the district. In turn, each professional development team creates professional development for the teachers at its school site, as set forth by SBER 6A-5.071 and Florida Statute 1012.98.

The school district employs 12,343 instructional staff members: 5,056 elementary, 4,945 secondary, and 2,342 other (Florida Department of Education, 2016). The study group was a stratified sample drawing from three strata (elementary, middle, and high school teachers). From the strata, a simple, random sampling was used. The sample size calculated using GPower software for the ordinal logistical regression was an a priori power analysis with an effect size of .1 (Blank & de las Alas, 2009), alpha equal to .05, power equal to .95, and 3 groups resulting in a total sample size of 176 teachers. For the

ANOVA, a slightly larger effect size of .15 -- chosen from the .01 to .2 range, indicated by Blank and de las Alas (2009) for effect sizes in professional development studies -- was used to ensure that a minimum number of participants was obtained to show differences amongst the variables. The ANOVA power analysis using effect size of .15, alpha equal to .05, power equal to .95, and 3 groups resulted in a total sample size of 690 teachers. Because power analysis was larger for the ANOVA, the researcher used the sample size of 690 for this study.

Individuals were recruited using stratified sampling for grade level of instruction; within the strata, there were subgroups made up of subject taught (STEM and non-STEM) and Title I status of the school (Title I and non-Title I). Each group was composed of educators who were employed by the district, instructed students in grades kindergarten through twelve, and partook in at least one professional development that the district or the school provided. The difference of each group was based on the grade level of instruction (elementary, middle, and high). Further differentiation occurred according to subject taught (STEM and non-STEM) and Title I status of the school (Title I and non-Title I). All else remained constant.

Participants

Participant selection occurred through two different processes: one for the interviews and the other for the survey. Both selection processes utilized the theory of Lave and Wenger's Community of Practice to properly place participants into community of practices: subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high).

From the 12 schools approved, the researcher purposely selected interview participants based on grade level of instruction, Title I status of the school, and subject taught (Figure 2). The researcher contacted teachers via email to request interviews (Appendix A). If the participant responded affirmatively, a time and date was set up for a face-to-face or telephone interview. The consent form was sent electronically to the participant and returned either via email or in person (Appendix B). Candidates that did not wish to participate were thanked for their time, and another teacher was contacted.

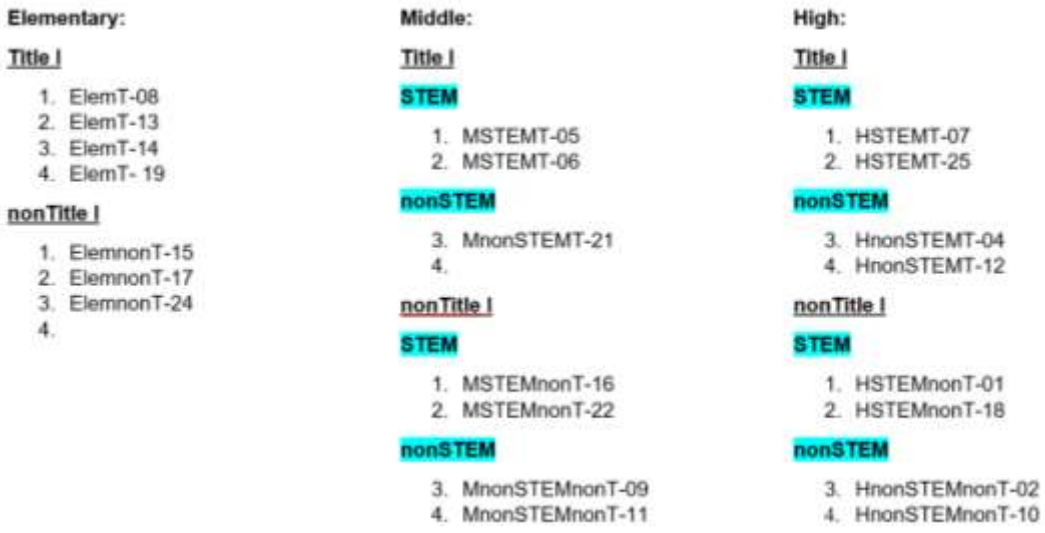

Figure 2. Interview participant organizer. The coding used to maintain participant confidentiality was as followed: elementary (Elem), middle (M), high (H), Title I (T), non-Title I (nonT), taught a STEM subject (STEM), and did not teach a STEM subject (non-STEM). The number flowing the classification referred to the order that the interview was conducted. Teachers received a code based on their grade level of instruction, Title I status of the school, and subject taught.

Through a public records request to the district, the researcher obtained a list including teachers' email addresses and school sites. Teachers at schools on the district's "no research conducted" list and those who did not meet the researcher's criteria were

filtered from the list. *Qualtrics* was used to send out emails that included a survey link to all instructional staff employed by the district (Appendix C).

Data Collection

Interview

To enhance the reliability of the nine components chosen by the researcher, the researcher conducted interviews. The rich data collected from the interviews investigated if teachers' perceptions regarding components included in an effective professional development design aligned with those chosen out of the 21 identified in the literature (Guskey, 2003). The interviews were conducted using a semi-structure method according to Merriam (2009). Teachers were asked questions from an approved protocol (Appendix D), but with some variation to questions to determine if the components chosen by the researcher were what teachers perceived as part of an effective professional development design. Interviews lasted approximately 25-30 minutes and were conducted over the telephone or face-to-face.

The interview protocol consisted of twelve questions: four background questions, seven questions exploring teachers' experiences of professional development trainings, and a final question that included the components chosen. Seven questions in the protocol had Lewin's Three-step Model of Change (Unfreeze, Moving, and Refreeze) interwoven into the construct to identify the problem(s) and/or what was lacking in the professional development designs. One of the seven questions asked each participant if things taught in the professional development were transferable in his/her classroom. Another asked the participant to describe what he/she would include in a professional development. These questions helped to identify the inertia in the current system and

included the targeted audience: two aspects found in the Three-step Model of Change. The last question contained the components selected by the researcher; participants were asked to identify and elaborate on whether or not the component was present in one of their professional developments.

Each interview candidate -- who was purposely selected based on communities of practices (Figure 2) -- received an email inquiring if he or she would like to participate in an interview (Appendix A). If the participant responded affirmatively, a time and date was set up for a face-to-face or telephone interview. The consent form was sent electronically to the participant and returned either via email or in person (Appendix B). In conjunction with American Educational Research Association (AERA), which respects an individual's rights and avoids possible harm, if a teacher contacted did not wish to participate, he or she did not have to and was thanked for their time. If for any reason the interview participant became unconformable, he or she had a right to end the interview and withdraw from the study at any time. Before questions were asked, participants received another chance to reaffirm that the recording was acceptable; if so, the interview conversation was recorded for later transcription and then coded using Excel. Data collection began right after the first interview to help direct the next interviews that were guided by the semi-structured protocol to obtain specific information (Corbin & Strauss, 1990; Merriam, 2009).

Survey

The unique survey created by the researcher explored teachers' preferences regarding which components should be included in an effective professional development design and gathered data investigating if subject taught (STEM and non-STEM), Title I

status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influenced these preferences. Using the survey method, the researcher was able to obtain empirical data -- data that was more representative of the population, and could produce large quantities of data in a short amount of time (Creswell, 2014; Kelley, Clark, Brown, & Sitzia, 2003).

The sample survey contained 33 closed questions primarily summated five-point Likert-type (Appendix E). The survey began with an agreement question regarding informed consent and complying with AERA policy. If a participant did not agree with the consent statement, then the survey was structured to move to the end with a thank you message. Questions two through nine allowed the researcher to determine if the participant met the criteria for inclusion in the survey. These criteria included instructing students in grades kindergarten through twelve, creating a community of practice (grade level of instruction, Title I status of the school, and subject taught), and having partaken in at least one professional development that the district or the school provided. Twenty questions were structured as summated five-point Likert-type. They measured the participant's level of agreement with the inclusion of components in an effective professional development design. A Likert scale provided more reliability for the survey questions and helped make better distinctions among responses (Johnson & Christensen, 2000).

By combining the theoretical models, Professional Development Framework (Loucks-Horsley et al., 2010), Practice Based Theory (Ball & Cohen, 1999), and High-Quality Professional Development: Content, Context, and Design (Darling-Hammond & Richardson, 2009), nine components were selected: 1. Content Knowledge, 2.

Pedagogical Knowledge, 3. Alignment with Policy and Goals, 4. Active Learning, 5. Collaboration, 6. Follow-up, 7. Duration, 8. Support, and 9. Resources (tangible and intangible). Included in these twenty questions were four questions that aided the researcher in collecting data to determine if differentiation was necessary for the community of practices: Grade level of instruction (elementary, middle, and high), Title I status of the school (Title I and non-Title I), and subject taught (STEM and non-STEM).

The conclusion of the survey contained an open-ended question asking each participant if there were any other components not mentioned that he or she felt should be included in a professional development design. The conclusion also asked participants questions about demographics (i.e. sex, ethnicity and race, and age) to be used for publication purposes. The survey was disseminated through *Qualtrics*, an online survey program purchased by Florida Atlantic University. The rationales for using an internet survey were cost-effectiveness and the easiness of accessing the sample via email with a link containing the survey (Fowler, 2009; Sue & Ritter, 2012). The software program consolidated data collection into one location. The researcher obtained email addresses for participants through a public records request after she received approval to conduct research from IRB and the district.

An email was sent to all instructional staff requesting their participation in the survey (Appendix C). Two weeks following the initial blast, a second request was sent via email (Appendix F) and remained open for another two weeks. The researcher consistently maintained participants' privacy by removing any face sheets (name, email address, and school) that the survey instrument might have collected. Participants' names and email addresses were only viewed and accessed by the primary investigators.

Qualtrics sent an email to participants using blind carbon copies ("bcc"), which ensured that other participants could not see who else received the email.

Increasing response rates is a challenge for survey studies. There were several strategies to help increase participant response rates, such as written endorsements, avoiding busy periods of time, creating a user-friendly questionnaire, and personalized messages sent with the survey (Altschuld & Lower, 1984; Evaluation Research Team, 2010). The researcher was mindful of hectic time periods, including grade deadlines, as well as Hurricane Irma's impact on the county. For this reason, the researcher pushed the initial timeframe back one month and created a survey that was not time-consuming. This survey had brief questions and easy-to-follow instructions; its design was appealing to the eye. To create a sense of personalization, the second email request for survey completion implied an understanding of busyness during the holiday season.

Reliability and Validity

Pilot Studies. The researcher used triangulation to provide internal validity for the interviews and survey pilot studies. She established triangulation through literature reviews for effective components and a pilot study conducted during EDA 7416 Advance Qualitative Inquiry, and used it in the interview protocol. The validity of the data for the interview pilot study included member-checking and transcriptions emailed back to the participants. The purpose of pilot testing was to establish content validity for the interview questions that the researcher used in this study.

Similarly, the researcher established survey reliability and validity through measurement validity and triangulation (Adcock & Collier, 2001; Merriam, 2009). The researcher conducted an extensive literature review to determine the nine components

selected. The same group of people used to conduct a pilot study for the survey were used in the final survey (Appendix G); this resulted in survey validity. The researcher conducted a pilot study in Spring 2017 in which she used the survey to measure teachers' preferences regarding components in an effective professional development design. Fourteen individuals were included in the analysis; not one was excluded. Cronbach's alpha was .943, indicating a high level of internal consistency for the survey (Kline, 2005). For the components, "emotional support" and "follow-up," participants' average responses were "neutral." For all other components, participants' average responses were "disagree." In terms of duration, most respondents (76.92%) preferred one to two hours of professional development per month, aligning with the literature recommendation of at least fourteen hours (Darling-Hammond & Richardson, 2009; Yoon et al., 2007).

Interview and Survey. The researcher chose the combination of quantitative and qualitative methods, multiple data analysis, and open-ended perspectives in triangulation to test for validity and reliability of interview and survey protocols (Golafshani, 2003; Patton, 2002).

After conducting the pilot studies, the researcher altered interview and survey protocols according to participants' recommendations. This helped provide validity to the instruments; the means of measurement were accurate, and they were measuring what they were intended to measure (Winter, 2000). The reliability of the survey component questions stemmed from interview-participants' responses, which replicated the components the researcher selected. The survey's internal consistency reliability had a corrected item-total correlation for each component greater than .3. The researcher employed a survey to measure different, underlying constructs. One construct,

component importance, consisted of 11 questions. The scale had a high level of internal consistency, as determined by a Cronbach's alpha of .860.

Variables

The researcher investigated three categorical independent variables in this study: Subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high). The dependent variable was the teacher's preferences for components from the nine selected by the researcher included in an effective professional development design. The researcher developed a cross-reference matrix of the survey questions, interview questions, research variables, and research questions to help create congruency (Appendix H).

Independent variable 1 (IV1), subject taught, was operationally defined as full-time K-12 teachers instructing students in a core curricular course defined by Florida Statue as necessary for grade level promotion and/or graduation. The variable is divided into two subcategories: STEM-teachers who instruct in science, technology, engineering and/or mathematics- and non-STEM-subject taught, including language arts/reading, social studies, English language arts, physical education, preforming arts, speech and debate, or practical arts (Fla. Stat., 2016). To determine which subcategory each elementary teacher was to be placed in for subject taught, the researcher asked him or her an additional question regarding which subject he or she felt strongest in, in terms of content knowledge (language arts/reading, social sciences, mathematics, or science).

Title I status of the school was independent variable 2 (IV2). As stated on the district's website, a school's "eligibility for Title I funding for this school year (FY17) is based on the school's percent of Free/Reduced Price Lunch eligible students as of

December 18, 2015." For this research study, IV2 was broken into two subcategories: non-Title I -- schools that were not eligible for funding, and Title I -- schools that have a high percentage of students who come from economically disadvantaged families, as defined by Part A (Title I) of the Elementary and Secondary Education Act (United States Department of Education, 2015b).

The third independent variable (IV3), grade level of instruction, was a full-time educator who provided instruction to a specific grade. Grade level of instruction contains three subcategories: elementary, middle and high. Elementary or primary level educators taught students in grades kindergarten (K), first (1^{st}), second (2^{nd}), third (3^{rd}), fourth (4^{th}) or fifth (5^{th}). Middle grade instructors were teachers of students who were in sixth (6^{th}), seventh (7^{th}), or eighth (8^{th}) grade. High school instructors included teachers of ninth (9^{th}), tenth (10^{th}), eleventh (11^{th}), or twelfth (12^{th}) grade students. In this study, middle and high may be combined and referred to as secondary level of instruction, or just secondary.

Teachers' preferences regarding which components should be incorporated into an effective professional development design was the dependent variable. The preferences ranged from strongly disagree to strongly agree. Survey questions for components were phrased as follows: "For me [component] is an important aspect of a professional development design." The nine components selected from the literature and validated by interviews were content knowledge, pedagogical knowledge, active learning, alignment with goals and policies, duration, support, collaboration, resources (tangible and intangible), and follow-up. Each component was defined for the participant in the survey (Table 3).

Table 3

Component Definitions in Survey

Component	Definition
Content Knowledge	The topic or matter dealt with in a field of study (i.e. science, reading).
Pedagogical Knowledge	Pedagogical methods taught during PD (i.e. scaffolding, differentiated instruction, problem based learning).
Active Learning	Modeling new strategies and practice.
Support	Interaction with professionals in the field; emotional; administrative.
Collaboration	Methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email.
Resources (tangible)	"Take-aways" i.e. worksheets, website links, workbook, lab equipment.
Resources (intangible)	Relate-ability to classroom; able to bring back to the classroom and use.
Aligned with Goals and Policies	Being part of a school or district based reform effort.
Follow-up	A person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring.
Duration	Received at least 14 hours (spread out over several trainings) of meaningful professional development training.

Data Analysis

Interviews

Interview data were coded from the start to begin the process of categorical construction. Analyzing the data as it was collected allowed the researcher to identify patterns that spanned across all the data and within some, a priori codes (content

knowledge, pedagogical knowledge, active learning, alignment with goals and policies, collaboration, duration, support, resources (tangible and intangible), and follow-up). However, it did not rule out open-coding of the interviews that identified other key words and phrases related to the research questions (Merriam, 2009). The researcher developed a priori codes (including content knowledge, pedagogical knowledge, active learning, follow-up, collaboration, tangible and intangible resources, alignment with goals and policies, support, and duration), as well as key words and phrases, into themes and entered in Excel for further analysis. This allowed her to consolidate and interpret what people had said (Merriam, 2009). For the first level of coding, the researcher employed in vivo coding, allowing her to use the participants' own language, and descriptive coding (Figure I1, I2, and I3). For the second level of coding, the researcher used pattern coding. The second-level coding allowed the researcher to place codes under a priori categories (Figure I1), as well as create two more themes and four more categories under each theme (Figure I2 and I3). As codes and then themes emerged, axial coding became apparent, further grounding the reality of data (Corbin & Strauss, 1990; Creswell, 2013). The analysis concluded with selective coding, which helped determine the degree of overlap between components chosen by the researcher and components that teachers perceived as part of an effective professional development design.

Survey

The researcher analyzed the survey through the following steps: First, the number of respondents and non-respondents were tabulated. Next, to minimize response bias, two weeks after the initial email requesting participation in the survey, a second email was sent to those who had not yet completed the survey (Appendix F). The third step in

the analysis was to complete an ordinal logistic regression for the multiple categorical independent variables and ordinal dependent variable using SPSS. Following the ordinal logistic regression, the researcher analyzed the survey data further using a three-way repeated measures ANOVA. She used this with an overall value of professional development components to determine if there were any interaction between the independent variables (Field, 2009; Stevens, 2009). During the final analysis, the researcher used themes that arose in the data from the qualitative portion of the study. Likewise, she used an ordinal logistic regression analysis of three questions about differentiation based on subject taught, Title I status of the school, and grade level of instruction from the survey.

Chapter Summary

The research design for this study was an embedded mixed method. It was an overall causal-comparative design embedded with interviews. The structure of the design allowed first verification of alignment for the nine components chosen. Keeping in mind Lewin's Three-step Change Theory, the interviews were also used to identify the inertia that existed in trainings offered to teachers. Using surveys influenced by Professional Development Framework (Loucks-Horsley et al., 2010), Practice Based Theory (Ball & Cohen, 1999), and High-Quality Professional Development: Content, Context, and Design (Darling-Hammond & Richardson, 2009), data were then analyzed quantitatively. The researcher used this data to investigate if subject taught, Title I status of the school, and grade level of instruction (communities of practice) influenced teachers' preferences for components included in an effective professional development design.

IV. RESULTS

In this embedded mix method study, the researcher investigated whether subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, high) influenced teachers' preferences regarding the components included in an effective professional development design.

The researcher conducted interviews first to investigate the perceptions of effective professional development design among K-12 school teachers in a large public school district located in the southeastern part of the United States. She interviewed using a semi-structure method according to Merriam (2009) and asked questions from an approved protocol (Appendix D). However, she varied some questions to determine if the components she chose matched what teachers perceived to be part of an effective professional development design. Categorical construction began with a priori codes (content knowledge, pedagogical knowledge, active learning, alignment with goals and policies, collaboration, duration, support, resources (tangible and intangible), and follow-up), but did not rule out open-coding of the interviews to identify other key words and phrases related to this study (Merriam, 2009). Codes and then themes emerged; this led to axial coding, which helped to "relate to and surround the core phenomenon" (Creswell, 2013, p. 86) and further ground the reality of data (Corbin & Strauss, 1990). Using these processes to analyze the data allowed the researcher to consolidate and interpret what people had said (Merriam, 2009). The analysis finished with selective coding (Figures I1, I2, and I3). After the researcher had coded all interviews, she determined the degree

to which the components she perceived as part of an effective design – and the components teachers perceived as part of an effective design – aligned.

The interviews were followed by a unique survey that the researcher created. The survey explored teachers' preferences regarding which components should be included in an effective professional development design. Using the survey method, the researcher obtained empirical data -- data that represented the population, and could produce large quantities of data in a short amount of time (Creswell, 2014; Kelley et al., 2003). The survey was a sample survey containing closed questions (mainly summated, five-point, Likert-type questions). The researcher analyzed data collected from the survey with two statistical methods using SPSS: ordinal logistic regression and three-way repeated measures ANOVA.

The ordinal logistic regression determined which (if any) of the independent variables had a statistically significant effect on the dependent variable, and determined how well the model predicted the dependent variable. The researcher analyzed survey data further using a three-way repeated measures ANOVA to determine if there was any interaction between the independent variables using an overall value of professional development components (Field, 2009; Stevens, 2009). During the final analysis, the researcher used themes that arose in the data from the qualitative portion of the study. She also used an ordinal logistic regression analysis of three questions about differentiation based on subject taught, Title I status of the school, and grade level of instruction from the survey.

Research Questions

1. What are perceptions of effective professional development design components among K-12 school teachers in a large public-school district located in the southeastern part of the United States?
2. Do factors such as subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, high) influence teachers' preferences among the components included in an effective professional development design?
    a. Does subject taught (STEM and non-STEM) influence preferences regarding components that should be included in an effective professional development design?
    b. What are the differences, regarding preferences for components that should be included in an effective professional development design, between the teachers at Title I schools and teachers at non-Title I schools?
    c. What are primary and secondary teachers' preferences regarding which components are part of effective professional development design?
    d. Are the differences in the components of the professional development design between STEM and non-STEM teachers a function of the Title I status of the school (Title I and non-Title I)?

Research Question 1 Results

Description of Interview Participants

From the 12 schools approved, the researcher purposely selected interview participants based on grade level of instruction, Title I status of the school, and subject

taught (see Figure 2). The interview participant recruitment started at the beginning of September 2017 and ended the second week of November 2017. The researcher sent emails to 276 teachers requesting interviews; 40 responded affirmatively, and 26 interviews were conducted. From the 26 interviews conducted, only 22 were used in this study. Due to time constraints and unpredictable weather, the researcher did not obtain a fourth Title I elementary school teacher or a non-Title I middle school STEM teacher interview.

The number of years of teaching experience among members of the interview participant pool ranged from two years to 37 years, with an average of 15 years in education. All but four participants got most of their teaching experience in the district, and two of the four taught at a private school located in the same area as the district. These participants included teachers who had partaken in at least one professional development that the district or the school had provided. There were ten STEM teachers interviewed; two were elementary teachers. Teachers at Title I and non-Title I schools were evenly distributed. Seven participants were elementary educators, seven were middle school educators, and eight were high school educators.

Interview Analysis

The main purpose of the interviews was to add reliability to the nine components that the researcher chose from the 21 identified within the literature (Guskey, 2003). However, the researcher did not discard any data. In fact, during the analysis, three themes arose: components of a professional development design, structure of professional development, and negative aspects of professional development. The first theme contained nine a priori categories: content knowledge, pedagogical knowledge, active

learning, collaboration, support, alignment with goals and policies, duration, reflection, and resources (tangible and intangible). Note that the component resources was broken into two types -- tangible and intangible -- to better distinguish between the different types of resources. The term, intangible resources will be referred to as "transferability" because of how the interview participants described intangible resources. Some examples included:

- "[You can] take it back to your classroom."
- "The best professional development that you can come up with is the one that I can use tomorrow."
- "[Professional development] allow[s] me to throw new stuff into my course."
- "I would definitely stress tangible things that you can bring back to your classroom."
- "Something that [the teachers] can bring back to their classroom."

The teachers' descriptions of the component, "intangible resources" provided a strong rationale to further denote the differences between the two resources and provide more clarity for the definition of this component. From this point forward, we will refer to "intangible resources" as "transferability." The findings from the interviews were as follows.

Perceived a priori components in an effective professional development design. The researcher asked participants how often they attended professional development. A distinction between required/mandated and voluntary attendance arose in the data (see Figure 6). Interviewees were allowed the freedom to choose the

professional development they wished to describe. If that professional development was not a school or district-run training, they were then asked to describe a school or district professional development. When asked to illustrate the professional development attended, the nine components the researcher selected were mentioned in some form as shown in Figure 3.

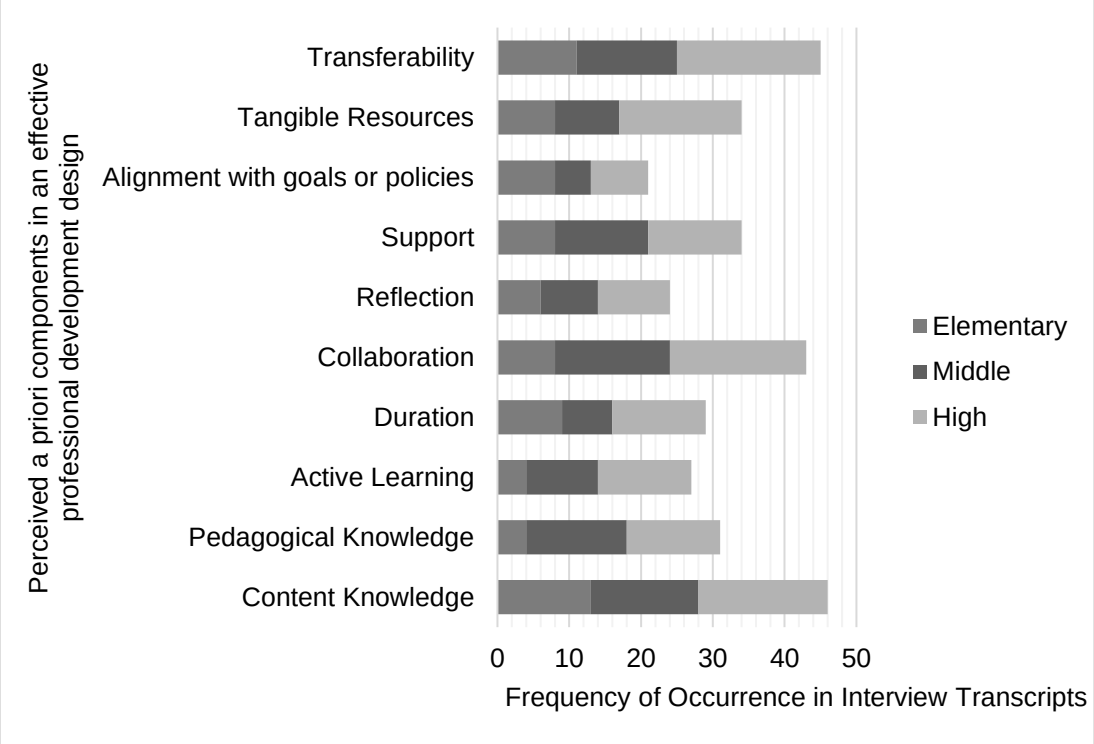

Figure 3. Interview component frequencies divided by grade level of instruction.

Active learning and pedagogical knowledge seemed to appear less frequently in elementary teacher professional development than in secondary teacher professional development. The teachers' perceptions of components included in an effective professional development design aligned with those the researcher selected. The rich data that the researcher collected from the interviews offered a form of reliability; components paralleled those offered within the survey that was later administered.

To ensure that there were no variations in the independent variable groups, the researcher analyzed the frequency of component occurrence for STEM versus non-STEM and Title I versus non-Title I teachers. Figure 4 showed a variation between STEM and non-STEM teachers for the component content knowledge. STEM teachers mentioned that their professional development was content-specific (the component, content knowledge) more often than non-STEM teachers. One participant stated that, "if it is related to algebra and a way to do things, like specific activities I do attend."

The STEM teachers spoke about having support and tangible resources that professional development provided. A teacher indicated that the "[district] has made a lot of the resources available to [him]." This was in reference to the online material teachers are able to access through the district portal. A high school STEM teacher attended a district training to unpack standards. He indicated that support with a mentor-teacher had a positive impact. "Having that experience with the mentor teacher is always phenomenal."

The researcher interviewed fewer STEM teachers, but based on the descriptions these teachers gave, the professional development that STEM teachers experienced seemed to be structured to include all the components that literature has indicated as part of an effective professional development design. This is not to say that non-STEM teachers do not have well-structured professional development; it is just that those interviewed for this study did not mention this at all or as frequently during the interview (Figure 4).

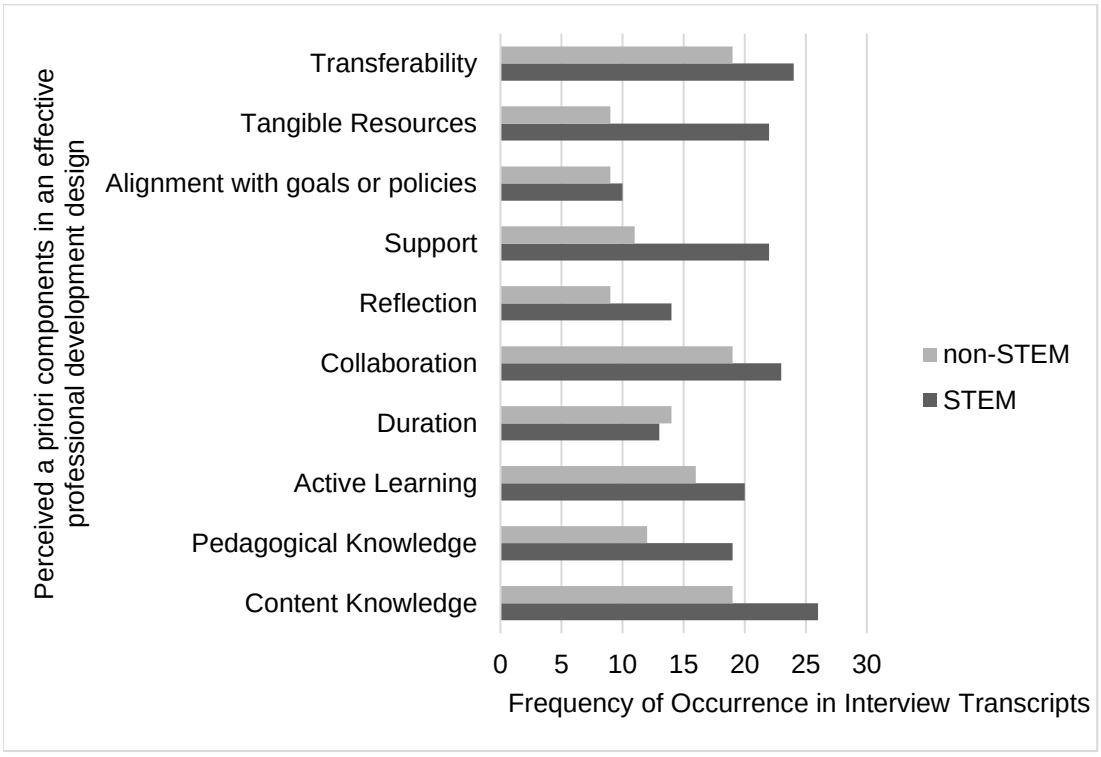

Figure 4. Component frequencies from the interviews by STEM versus non-STEM.

Like STEM versus non-STEM teachers, Title I teachers mentioned that the professional development they experienced included the components literature has indicated are part of an effective professional development design more often than non-Title I teachers. There were two components Title I teachers cited frequently: transferability and collaboration (Figure 5). A quote from a Title I teacher who described how professional development was conducted in his school emphasized this difference. In the professional development trainings,

> Sometimes it would be best practices or maybe rotating and visiting other teachers for 30 minutes and watching them conduct a lesson so that it is not always in your curriculum. You might pick up on how they use technology. You might pick up on how to do an exit ticket, stuff like that.

Again, it is not to say that non-Title I teachers did not experience collaboration, but it appeared that Title I teachers were exposed to various types of collaboration more often.

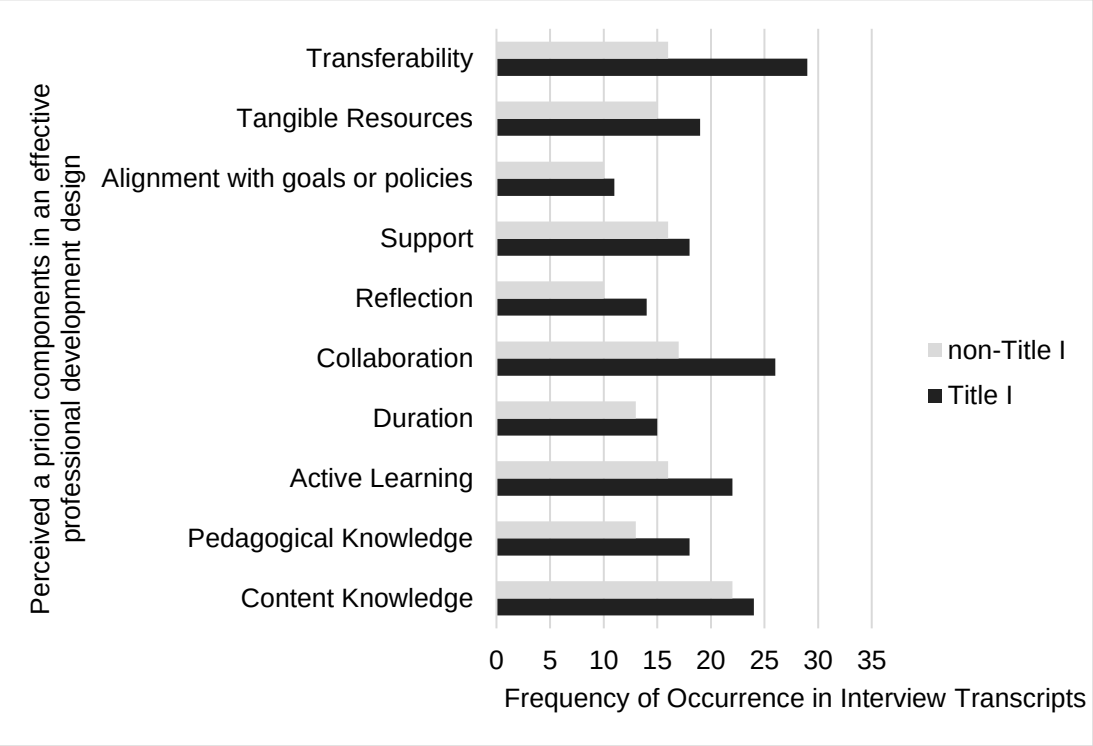

Figure 5. Interview component frequencies from Title I versus non-Title I teachers.

The component, transferability could be defined as the ability to bring training back to the classroom – in other words, relatability. A non-Title I teacher declared, "The professional developments that I have really enjoyed have been the ones that were personally useful to me." Out of all the components, interviewees mentioned transferability the second most frequently (Figure 3); Title I teachers mentioned transferability most frequently (Figure 5).

Other constituents for the overall professional development structure. Though the purpose of the interviews was to add reliability to the components selected for the survey, other themes arose during the coding process that the researcher felt needed to be addressed. The theme structure of professional development included

categories for attendance (by choice and required to attend), session types, and altered/modified resources.

When participants were asked how often they attended professional development when offered the opportunity, some of the responses were:

- "Are you excluding mandatory ones, like I just voluntarily chose to go?"
- "If it's mandated."
- "We're kind of required to do them."
- "They make us."

Even though these responses seem negative, the researcher asked each participant to describe one by-choice professional development, and then a school or district-mandated professional development. Given a choice, many of the teachers interviewed described a professional development they attended that was not district or school-run. The replies for the questions had more positive responses, such as

- "First part usually [involves]… unpacking [the] standards… second half would be going over the way to teach the particle, the laboratory side to that, which to me is always the best."
- "Some of the best professional development as far as getting strategies, ideologies to take back into the classroom [came from a non-district training]"

When then asked to describe a school or district training, many teachers indicated that components were present, but made negative side comments.

> I can tell you about one I went to… it was at the district level… [the] training was about a new set of science materials… it turned out to be almost like an

introduction in how to teach ESOL… I felt almost insulted in a away because it was so basic.

These negative aspects are discussed in the third theme below.

Teachers described a professional development training that they experienced containing small groups or mini sessions to select from (see session types in Figure 6). An elementary teacher stated that during a professional development training they were divided, "sometimes [into] groups and by grade level."

All classifications of interviewees indicated that they received tangible resources from their professional development in the form of worksheets, websites, or workbooks (see Figure 3). Only middle school STEM teachers denoted that they would modify or alter some pedagogical strategies taught and the tangible resources to better fit their needs (Figure 6). "I would take the rubric they gave us and change it so that it [was] readable." Unlike attendance and session types, altering/modifying tangible resources could fall under the reflection component. The reflection component comes into play when teachers determine how they can use the training in their classroom. Teachers mentioned this component the second least frequently during the interviews (see Figure 3). The lower frequency indicates that the component is not always present in the professional development designs. After the interviewer asked about reflection, one teacher stated that, "I wish that… the reflection might be more important. Give us time to be able to talk to each other and how we could work it."

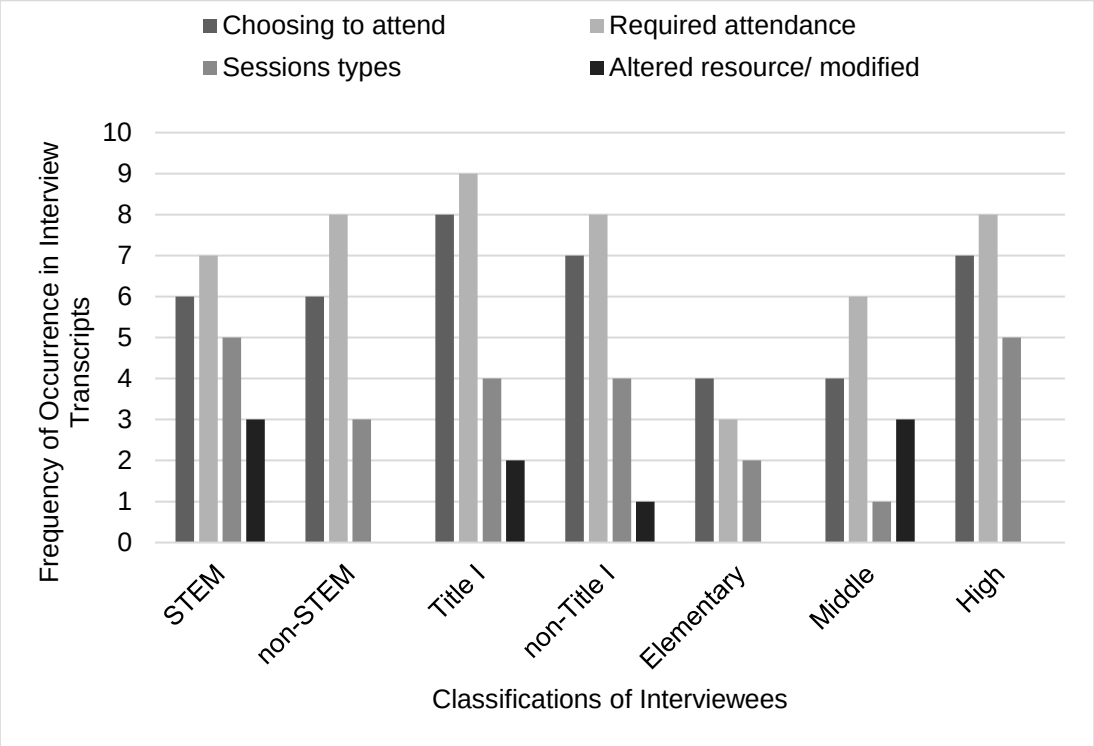

Figure 6. Frequencies of codes for other constituents for the overall professional development structure theme.

Negative aspects about professional development. Though not looking for this theme, the majority of the participants expressed negativity toward aspects of professional development. They made sure that the researcher understood that they saw the value of professional development, but pointed out that improvements needed to be made; in other words, what professional development lacked made it less beneficial.

Wanting to attend versus being required to attend might impact a teacher's experience in professional development. Poorly structured or presented professional development impacts teachers' experiences negatively. Without prompting, seven of the participants described these professional developments as "a waste of time." Figure 7 shows that none of the STEM teachers, when compared to non-STEM teachers, expressed that the professional development they had received from their school site or

district was a waste of time. However, teachers of all grade levels voiced the sentiment, "a waste of time" in some fashion. One way that teachers expressed this waste of time included, "I felt myself getting a little annoyed because it was so basic, and it was a real waste of my time." Yet another teacher was quoted,

> I actually went to a session and you're not going to believe this… that was all about [a] computer based data base and we didn't have computers in front of us… I got up and went to the coordinator and I said what are you doing you are losing your audience why aren't we in a computer lab? [The trainer responded] "I couldn't get one." [Interviewee responded] Then why are we here this is useless to us.

A second category for this theme was the lack of relevance found within professional development. All teachers interviewed expressed how the professional development they had attended at the school site or district was irrelevant, but non-Title I teachers and middle school teachers expressed this more frequently (Figure 7).

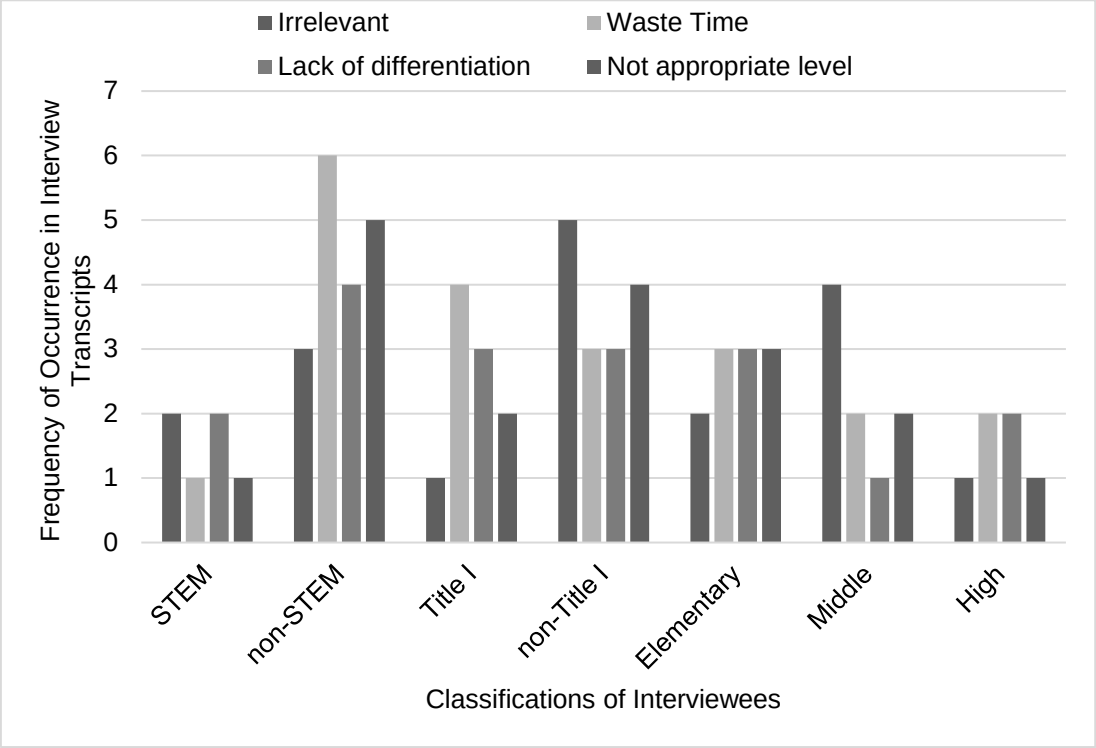

Figure 7. Frequencies of codes for negative aspects of professional development theme.

One teacher suggested that, "professional developments should be offered at different levels." This created a third category of inappropriate levels. Elementary teachers, non-STEM teachers, and non-Title I teachers were more likely to express that the professional development they encountered at their school sites or at the district was not appropriately leveled (Figure 7).

A seasoned teacher reflected on the professional development offered at his school.

> Sometimes, I feel like it's a one-size-fits all because we have a pretty big turnover of teachers. Although there are a lot of older teachers that have been there a long time…we have to do the same stuff [as the new teachers].

Another teacher had parallel sentiments about the professional development offered at his school, "Yah, it wasn't anything new. It was the stuff we already know. I think it was

for just the new teachers, but they just can't say this is for the new teachers, so everyone has to go."

The last category for this theme was lack of differentiation. Whether STEM or non-STEM, Title I or non-Title I, elementary, middle, or high, interview participants mentioned the lack of differentiation in the professional development that they experienced at their school sites or in district trainings (Figure 7). None of the interview questions asked about differentiation in the professional development, yet the teachers mentioned a lack thereof in one form or another. One teacher blatantly stated, "my biggest issues with professional development is the lack of differentiation." Non-STEM teachers expressed recognition of a lack of differentiation five times more frequently than STEM teachers. Four Title I and three non-Title I teachers expressed that they recognized a lack of differentiation. Elementary teachers expressed recognition of a lack of differentiation more frequently than middle and high teachers (Figure 7). Part of the issue could be the one-size-fits-all direction that professional development has gone in. Another possibility could be the high rate of teacher turnover; about half a million teachers leave the field annually, according to Alliance for Excellent Education (2015).

Interview analysis summary. The rich data collected from the interviews provided the researcher with a form of reliability for the survey. The interviewees all stated that the nine components the researcher selected were part of their professional development. This allowed the researcher to move forward confidently with the component questions on the survey.

Research Question 2 Results

This study used an ordinal logistic regression and three-way repeated measures ANOVA analyses to predict if subject taught, Title I status of the school, and grade level of instruction influenced teachers' preferences for components included in an effective professional development design. Note that the component support was broken into support and emotional support so that participants would be able to differentiate between them. Also, note that resources was broken into tangible and intangible to better distinguish between the different types of resources. As noted earlier, to further denote the differences between the two resources and provide more clarity regarding how one might define, "intangible resources," we will continue to refer to this component as "transferability."

Participant Description

Through a public records request to the district, the researcher obtained a list including teachers' email addresses and school sites. Teachers at schools on the district's "no research conducted" list and those who did not meet the researcher's criteria were filtered out. Starting in mid-November 2017, the researcher sent out 11, 267 emails. She sent a reminder email to participants who had started or had yet to start the survey two weeks after the initial blast. Upon closing the survey one month following commencement, a total of 878 had responded: a response rate of 7.79%. The response rate for this survey was low according to a review of several online survey studies, which revealed that the average response rate was 33.3% (Nulty, 2008). Several factors could have contributed to the low response rate. First, inclement weather caused schools to close for seven days. Interviews were to be conducted before the survey went out,

creating a several-weeks delay in the completion of the interviews. The lost days may have resulted in the district requiring teachers to implement the missed curriculum, as well as continue with the material allotted for the days after schools reopened; this may have generated stress for many teachers. These teachers may have completed the survey during times throughout the day, but the missed days may have left some teachers feeling as if there was not extra time to complete the survey. The days missed removed a full professional development day and a teacher work day from the schedule. This may have alienated participants who would have completed the survey on either of these days. Lastly, the seven days missed pushed deadlines for teachers' grade submissions. The new deadlines were at the beginning of the survey window for middle and high school teachers, and landed in the middle for elementary.

After removal of respondents who did not complete the survey entirely, did not select Title I status, grade level of instruction, and/or teaching a STEM subject, and did not participate in a school or district professional development, 622 survey participants remained.

The years teaching for participants ranged from one year to 48, with a mean of 16 years, and median of 15 years of teaching experience. Table 4 provides the descriptive statistics of the survey participants: frequency of STEM teachers, Title I, grade level taught, and sex. Participants are close to an even distribution for Title I (48.2%) and non-Title I (51.8%) and STEM (46.8%) and non-STEM (53.2%). Grade level of instruction, when broken into elementary (44.9%) and secondary (middle and high combined -- 55.1%), is almost evenly distributed. Sex is greatly skewed toward female (83.6%), but this is not uncommon for the education profession. According to the National Center for

Educational Statistics (2014), 76 percent of public school teachers were female in 2011–12, which has remained about the same for over 30 years.

Table 4

Descriptive Statistics for Survey Participants

	Frequency	Elementary	Middle	High
Teaches at Title I				
Yes	300	167	54	79
No	322	112	81	129
Teaches STEM				
Yes	291	169	58	64
No	331	110	77	144
Grade Level				
Elementary	279			
Middle	135			
High	208			
Sex				
Male	98			
Female	520			
Missing	4			

Figure 8 describes the ethnic and racial makeup of the survey pool, which is comprised of majority white (72%). According to the United States Department of Education, Office of Planning, Evaluation and Policy Development, Policy and Program Studies Service (2016) the racial makeup of public-school K-12 educators has remained about the same -- 82 percent white in public schools. They also stated, “elementary and secondary educator workforce is overwhelmingly homogenous” (p. 3).

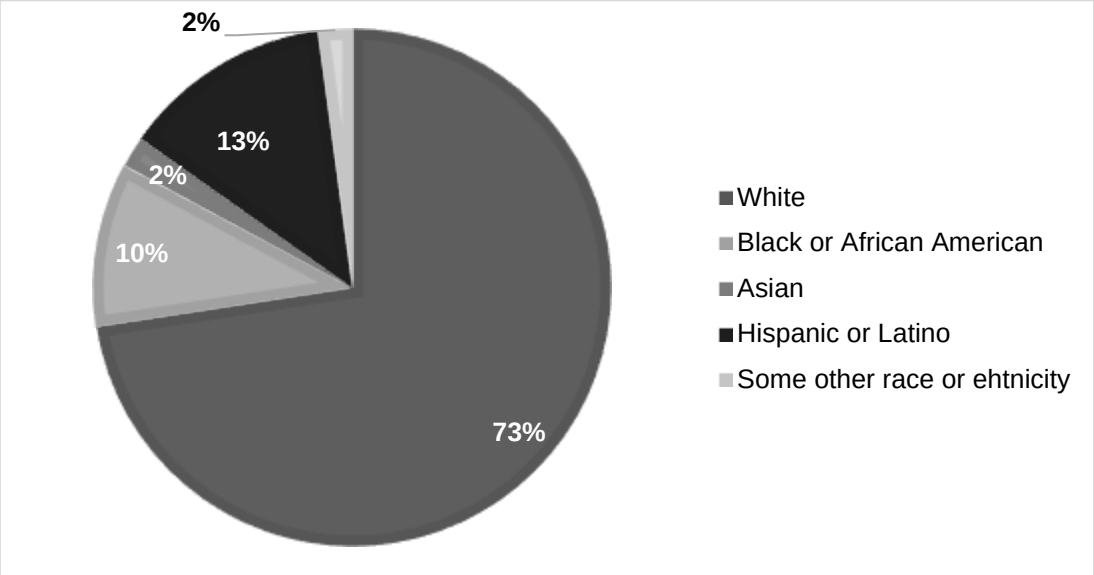

Figure 8. Survey participant percentages of ethnicity and race.

Survey Analysis

Analysis of the survey data were broken into an ordinal logistic regression, used to analyze the data for research questions 2, 2a-2c, and a three-way repeated measures ANOVA for research question 2d.

Assumptions for the ordinal logistic regression. The dependent variable components of an effective professional development design were measured using a Likert type scale: 1 (strongly disagree) to 5 (strongly agree). The researcher investigated three categorical independent variables: subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high).

There was no collinearity for the dependent variable using dummy codes for grade level of instruction, subject taught, and Title I status of the school (Table J1). The assumption of proportional odds was met by all but two of the dependent variable subcategories (content knowledge and follow-up), as assessed by a full likelihood ratio

test comparing the fit of the proportional odds location model to a model with varying location parameters (Table J2).

For content knowledge and follow-up, the researcher ran a binomial logistic regression to determine if the violation of proportional odds that the full likelihood ratio test flagged was valid. For the component, content knowledge, the odd ratios of the four different binomial logistic regressions were similar for the independent variable subject taught (-.426, -.283, -.367, -.246), making it appear as if the assumption of proportional odds was tenable. However, for the two other independent variables, this was not the case. Thus, the researcher had to treat the variable with caution (Table J3). The component follow-up did not meet the proportional odds assumption for any of the independent variables (Table J4). Since the proportional odds assumption was not met by every component, this study continued as an exercise in conducting research.

The researcher found 12 covariates patterns in the ordinal regression analysis. The cell pattern for the dependent variable levels by combinations of predictor variable values was 612. This generated most warnings with low percentages or few cells with zero frequency. There were many cells with small expected frequencies, decreasing the reliability of the goodness-of-fit, but as an exercise, the researcher looked at them. The deviance goodness-of-fit test indicated that the model, except for content knowledge and pedagogical knowledge, was a good fit for the observed data (Table J5). For the final model, the independent variables did not add to the prediction of the dependent variables. Overall, the final model was statistically significant for some categories (pedagogical knowledge, active learning, collaboration, and alignment with goals and policies) and not

statistically significant for all others. Thus, it did not predict the dependent variable over and above the intercept-only model (Table J6).

Research question 2a: Subject taught. Using an ordinal logistic regression allowed the researcher to interpret the odds that STEM teachers -- compared to non-STEM teachers -- placed a higher or lower degree of value on the components of an effective professional development design. There are five categories for this regression model, generating four cumulative logits and four equations. The reference category included teachers classified as non-STEM, or those teachers who indicated that they did not teach a science, technology, engineering, or mathematics course. There were positive coefficient "Bs" for STEM teachers, with the following dependent variable subcategories: content knowledge, active learning, alignment with goals and policies, tangible resources, and duration compared to the reference category.

The odds of STEM teachers scoring higher on the dependent variable subcategories, content knowledge (p = .103), collaboration (p = .065), and tangible resources (p = .083) were about 1.3 times that of non-STEM teachers, but not statistically significant (Table 5). The odds ratio was about the same in a category for STEM versus non-STEM teachers, which occurred in the dependent variable subcategories, pedagogical knowledge, active learning, support, emotional support, alignment with goals and policies, transferability, follow-up, and duration. Again, they did not have a statistically significant effect (Table 5).

Table 5

Estimates for the Parameters of the Generalized Linear Model for STEM versus non-STEM

Component	Exp(B)		95% Wald Confidence Interval for Exp(B)				Sig.*	
			Lower		Upper			
	STEM	non-STEM	STEM	non-STEM	STEM	non-STEM	STEM	non-STEM
Content Knowledge	1.314	1	.946	−	1.825	−	.103	−
Pedagogical Knowledge	.981	1	.718	−	1.340	−	.903	−
Active Learning	1.096	1	.786	−	1.529	−	.589	−
Collaboration	1.333	1	.982	−	1.810	−	.065	−
Support	.901	1	.665	−	1.219	−	.498	−
Emotional Support	.963	1	.717	−	1.293	−	.081	−
Alignment with goals and policies	1.065	1	.792	−	1.434	−	.676	−
Tangible Resources	1.317	1	.965	−	1.797	−	.083	−
Transferability	.972	1	.716	−	1.319	−	.855	−
Follow-up	.924	1	.687	−	1.243	−	.602	−
Duration	1.087	1	.810	−	1.459	−	.580	−

*$p < .05$

The frequencies for strongly agree and agree were as follows: STEM teachers were more likely to agree or strongly agree that each and every component was important to them and should be included in an effective professional development design (Figure 9). In response to the same survey questions, non-STEM teachers were more likely than STEM teachers to disagree or strongly disagree that the components, content knowledge, pedagogical knowledge, active learning, collaboration, support, alignment with goals and policies, transferability, follow-up, and duration were important in the design. More STEM teachers than non-STEM teachers disagreed only in the categories, emotional support and tangible resources (Figure 10).

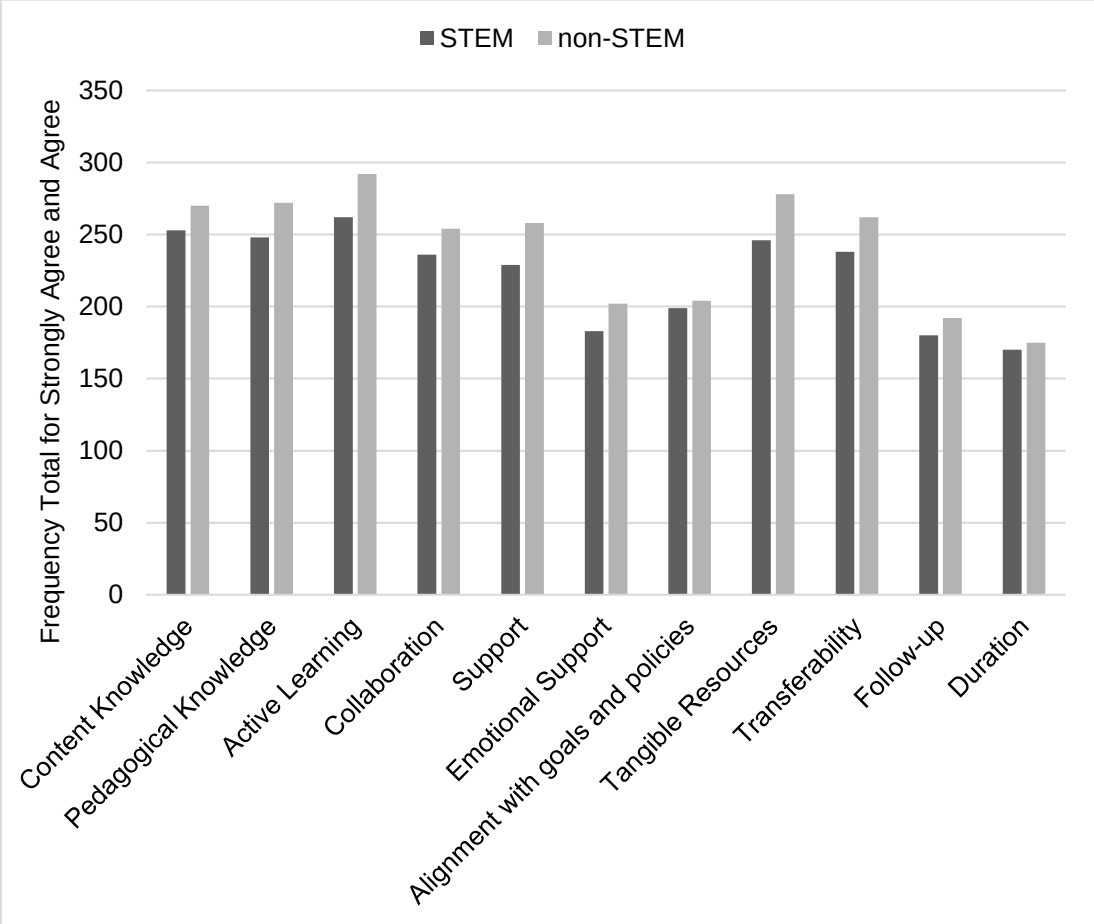

Figure 9. Agreement frequency totals of components for STEM versus non-STEM.

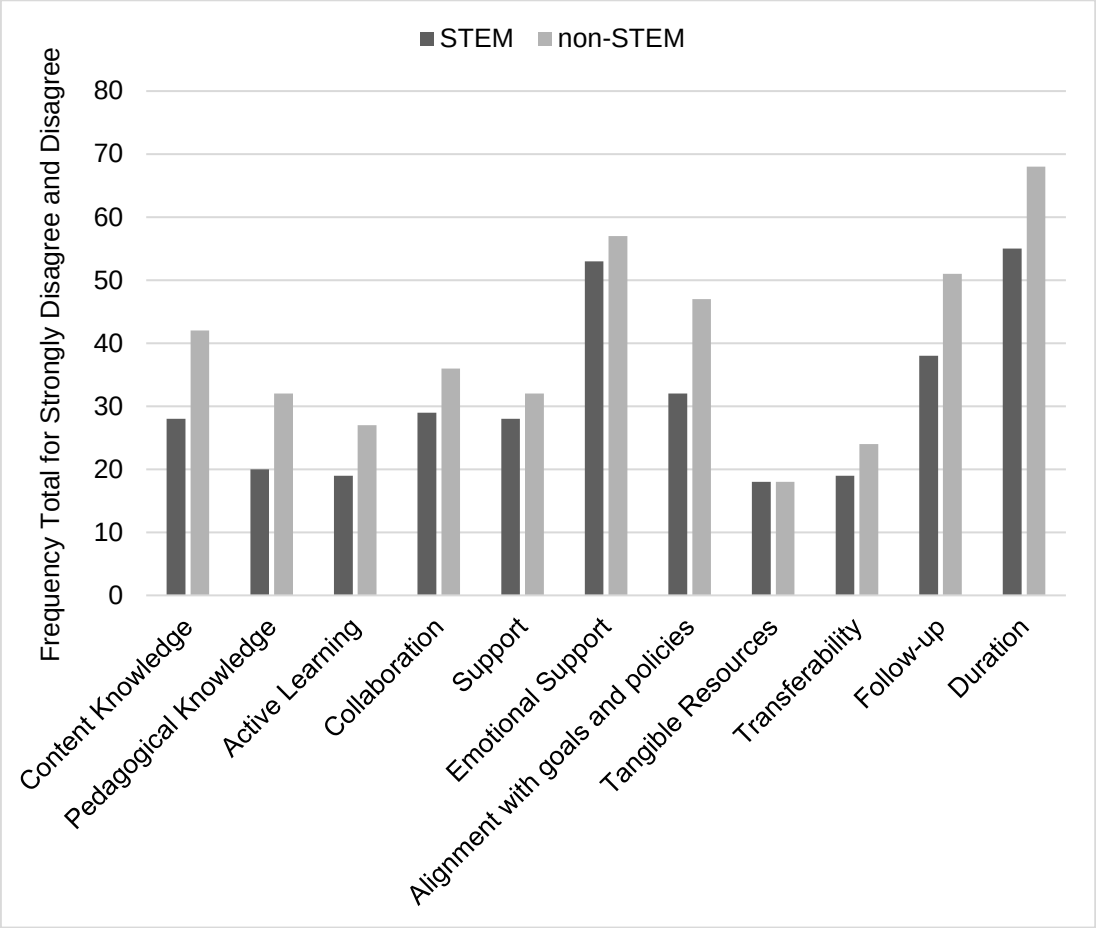

Figure 10. Disagreement frequency totals of components for STEM versus non-STEM.

Research question 2b: Title I status of the school. The ordinal dependent variable contained five categories – strongly disagreed, disagreed, neutral, agreed and strongly agreed – which allowed the researcher to interpret the odds that teachers at Title I schools placed a higher or lower value on the dependent variable than teachers at non-Title I schools. Using the reference category non-Title I teachers, or teachers not at Title I schools, several subcategories of the dependent variable had negative coefficients for "B": collaboration, support, and tangible resources. This indicated that there was a negative change in the log odds for these dependent variable subcategories for Title I teachers.

The odds ratio of being in a higher category of the dependent variable subcategories, pedagogical knowledge, alignment with goals and policies, follow-up, and duration was about 1.2 times as likely that Title I teachers would agree with the component importance versus non-Title I teachers; none had a statistically significant effect (Table 6). The odds of a teacher at a Title I school considering collaboration an important aspect of an effective professional development design was .715, 95% CI [.529, .966] times that of a teacher at a non-Title I school: a statistically significant effect, $\chi^2(1) = 4.784$, $p = .029$. Title I teachers and non-Title teachers had about equal odd ratios in the categories of content knowledge, active learning, support, emotional support, and transferability, but there was not a statistically significant effect (Table 6). Lastly, the odds ratio of being in a lower category of the dependent variable subcategory, tangible resources for Title I teachers versus non-Title I teachers was .773, 95% CI [.569, 1.050]: a statistically significant effect, $\chi^2(1) = 5.255$, $p = .022$.

Table 6

Estimates for the Parameters of the Generalized Linear Model for Title I versus non-Title I

Component	Exp(B)		95% Wald Confidence Interval for Exp(B)				Sig.*	
			Lower		Upper			
	Title I	non-Title I	Title I	non-Title I	Title I	non-Title I	Title I	non-Title I
Content Knowledge	1.011	1	.732	−	1.396	−	.947	−
Pedagogical Knowledge	1.232	1	.906	−	1.674	−	.183	−
Active Learning	1.123	1	.809	−	1.559	−	.488	−
Collaboration	.715	1	.529	−	.966	−	.029*	−
Support	.971	1	.720	−	1.308	−	.845	−
Emotional Support	1.121	1	.839	−	1.499	−	.440	−
Alignment with goals and policies	1.214	1	.905	−	1.627	−	.196	−
Tangible Resources	.773	1	.569	−	1.050	−	.100	−
Transferability	1.078	1	.798	−	1.457	−	.624	−
Follow-up	1.215	1	.907	−	1.626	−	.192	−
Duration	1.207	1	.903	−	1.613	−	.205	−

*$p < .05$

Figure 11 shows the frequency of Title I and non-Title I teachers' responses of "agreed" or "strongly agreed" to questions that asked about the importance of including specific professional development design components in the overall design. A greater percentage of Title I teachers responded positively to questions regarding inclusion of the components: content knowledge, active learning, support, emotional support, alignment with goals and policies, tangible resources, follow-up, and duration.

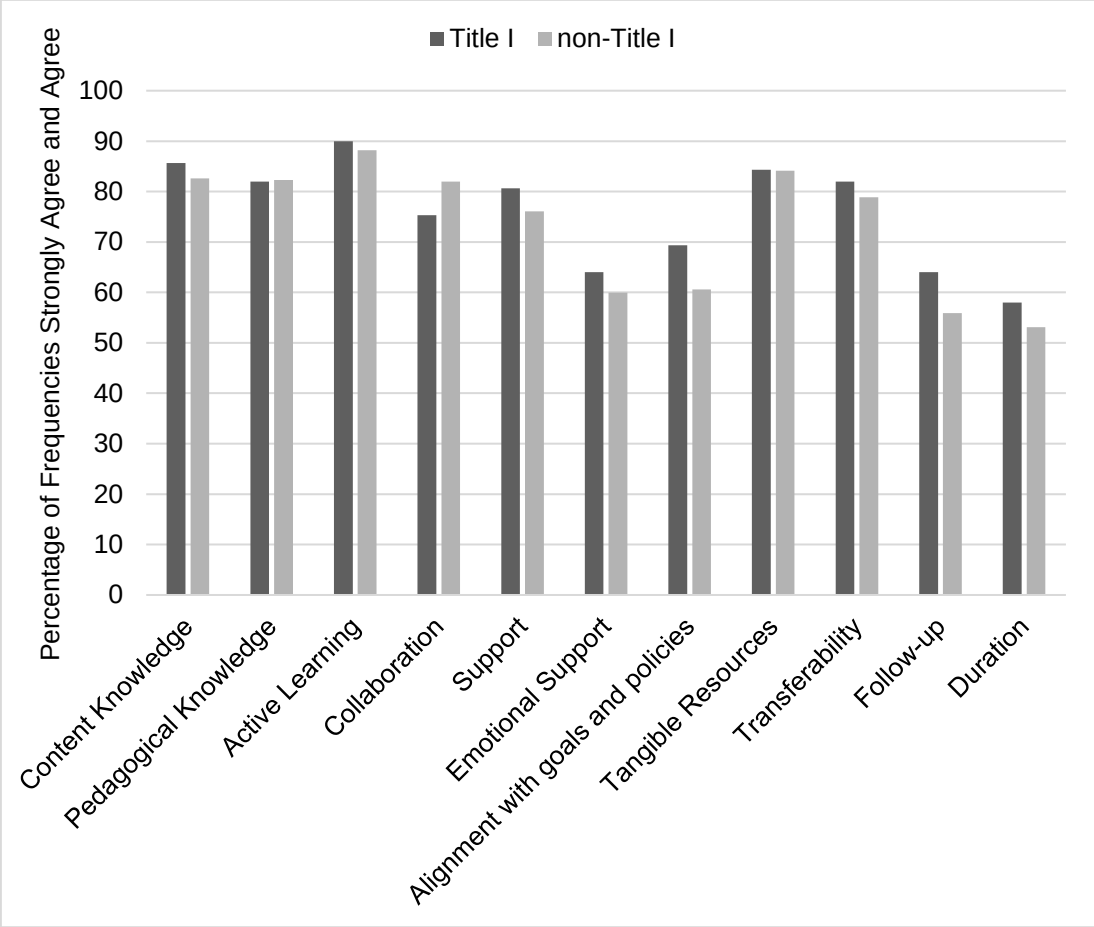

Figure 11. Agreement frequency totals of components for Title I versus non-Title I.

Even though Title I teachers agreed that the majority of the components the researcher selected should be included in an effective professional development design

more frequently than non-Title I teachers, they were also more likely to disagree that these same components should be included (Figure 12).

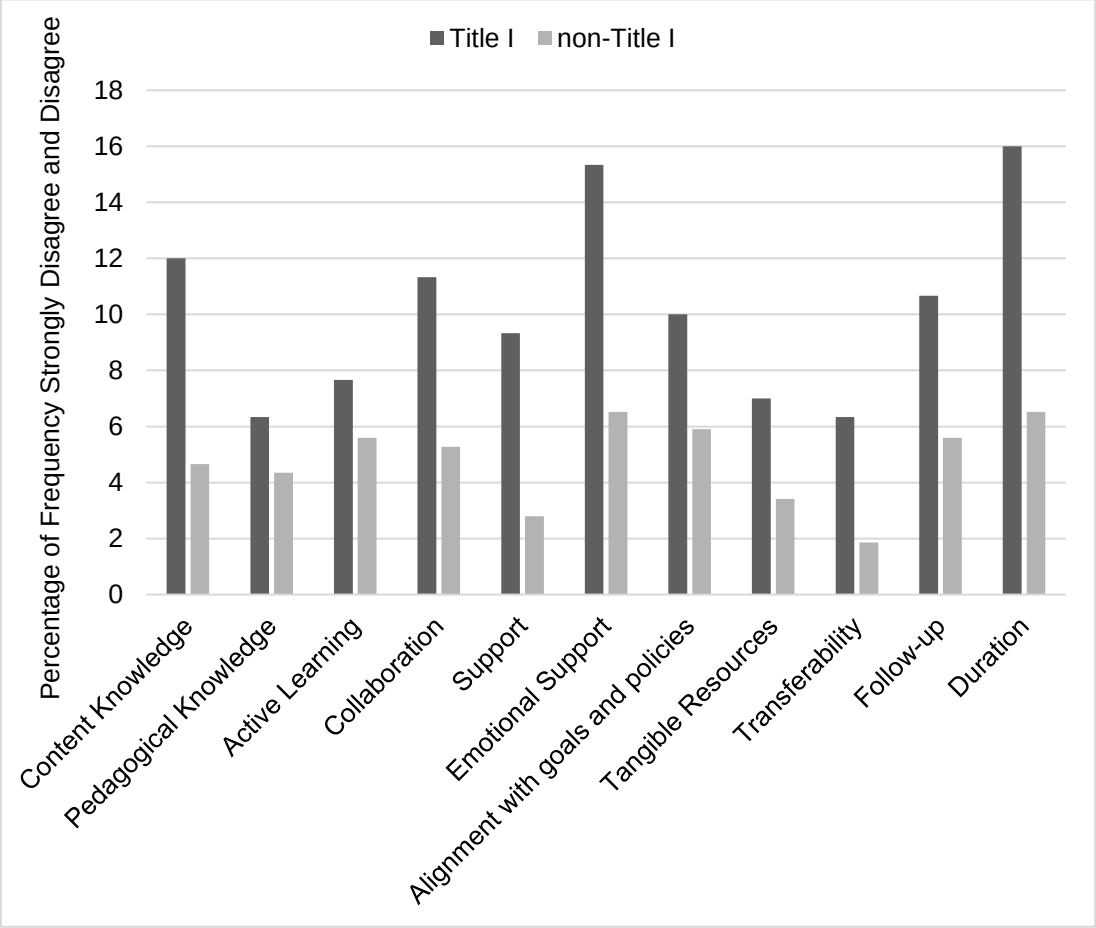

Figure 12. Disagreement frequency totals of components for Title I versus non-Title I.

Research question 2c: Grade level of instruction. Grade level of instruction is a polytomous variable broken into elementary, middle, and high school teachers. The reference category was high school teachers. When compared to elementary teachers, all components had positive coefficients "B." Compared to the reference category, middle school teachers had negative coefficients "B" for pedagogical knowledge, active learning, support, transferability, and follow-up.

The overall omnibus statistical test measured whether grade level of instruction had a statistically significant effect on the dependent variable. This test yielded mixed results. The reference category had a statistically significant effect on the prediction for the components, pedagogical knowledge (Wald $\chi^2(2) = 8.902$, $p = .012$), active learning (Wald $\chi^2(2) = 10.81$, $p = .006$), alignment with goals and policies (Wald $\chi^2(2) = 13.740$, $p = .001$), and transferability (Wald $\chi^2(2) = 6.045$, $p = .049$), but not for content knowledge, collaboration, support, emotional support, tangible resources, follow-up, and duration (Table 7). Because the researcher established that only four components were ultimately significant, she used only these four for further investigation.

Table 7

Test of Model Effects of the Generalized Linear Model for Grade Level of Instruction

Component	Wald Chi-Square	Sig.*
Content Knowledge	1.403	.496
Pedagogical Knowledge	8.902	.012*
Active Learning	10.081	.006*
Collaboration	3.252	.197
Support	4.787	.091
Emotional Support	2.551	.279
Alignment with goals and policies	13.740	.001*
Tangible Resources	.246	.884
Transferability	6.045	.049*
Follow-up	5.282	.071
Duration	2.042	.360

*$p < .05$

The odds of elementary teachers considering the inclusion of pedagogical knowledge were 1.509, 95% CI [1.051, 2.168] times that of high school teachers: a statistically significant effect, Wald $\chi^2(1) = 4.958$, $p = .026$. Elementary teachers were more likely to agree that active learning was important (odd ratio of 1.357, 95% CI [.920, 2.002]): not a statistically significant effect (Wald $\chi^2(1) = 2.374$, $p = .123$). When compared to elementary teachers, the odds ratio for alignment with goals and policies was almost double for high school teachers -- odd ratio of 1.913, 95% CI [1.352, 2.707]: a statistically significant effect, Wald $\chi^2(1) = 13.418$, $p = .000$. Lastly, the odd ratio for transferability was slightly higher for elementary teachers versus high school teachers. The exponential of the log odds was 1.099, 95% CI [.798, 1.457]: not a statistically significant effect, Wald $\chi^2(1) = .274$, $p = .601$.

The researcher concluded that the odds ratio of being in a higher category of the dependent variable subcategory, pedagogical knowledge for middle versus high school teachers was .863, 95% CI [.575, 1.296]: not a statistically significant effect, Wald $\chi^2(1) = 2.374$, $p = .478$. Compared to the reference group, middle school teachers considered active learning .689, 95% CI [.451, 1.054] times important to the design, and not statistically significant, Wald $\chi^2(1) = 2.942$, $p = .086$. The same could be said for transferability, odds ratio of .679, CI 95% [.453, 1.019], Wald $\chi^2(1) = 3.486$, $p = .062$. The odds ratio of being in a higher category for alignment with goals and policies for middle school teachers versus high school teachers was 1.282, 95% CI [.865, 1.901]: not statistically significant, Wald $\chi^2(1) = 3.486$, $p = .215$.

To investigate the third possible combination of elementary versus middle school teachers, the researcher ran the ordinal logistic regression using elementary as the

reference group. None of the four components had odd ratios in a higher category for the dependent variable for middle school teachers versus elementary teachers. For practice, the researcher reviewed each of the four components.

The odds of middle school teachers considering pedagogical knowledge an important component in an effective professional development design were .551, 95% CI [.373, .814], times that of elementary teachers: a statistically significant effect, Wald $\chi^2(1) = 8.954$, $p = .003$. The number of middle school teachers who considered active learning important to the design was almost half that of elementary teachers (odds ratio .486, 95% CI [.325, .737]): a statistically significant effect, Wald $\chi^2(1) = 11.691$, $p = .001$. The odds of middle school teachers -- compared to elementary teachers -- considering alignment with goals and policies important were .633, 95% CI [.436, .921], a statistically significant effect, Wald $\chi^2(1) = 5.730$, $p = .017$. Lastly, the odds of middle school teachers considering transferability important were .612, 95% CI [.417, .898] times that of elementary teachers: a statistically significant effect, Wald $\chi^2(1) = 6.280$, $p = .012$.

To ensure that the researcher collected data to answer the research question, she ran an ordinal logistic regression for grade level of instruction as a dichotomous variable: elementary and secondary. The overall omnibus statistical test results reflected that pedagogical knowledge ($p = .004$), active learning ($p = .008$), support ($p = .047$), alignment with goals and policies ($p = .001$), and follow-up ($p = .038$) had a statistically significant effect on the researcher's prediction of which components teachers preferred to be part of an effective professional development design.

The odds of elementary teachers considering the inclusion of pedagogical knowledge were 1.604, 95% CI [1.164, 2.209], times that of secondary teachers: a statistically significant effect, Wald $\chi^2(1) = 8.366$, $p = .004$. Elementary teachers' odds ratio for alignment with goals and policies was almost double that of secondary teachers, odd ratio of 1.720, 95% CI [1.267, 2.334]: a statistically significant effect, Wald $\chi^2(1) = 12.105$, $p = .001$. For odds ratios for each of the components, see Table 8.

Table 8

Estimates for the Parameters of the Generalized Linear Model for Elementary versus Secondary Teachers

Parameter	Hypothesis Test			Exp(B)	95% Wald Confidence Interval for Exp(B)	
	Wald Chi-Square	df	Sig.*		Lower	Upper
Content Knowledge	1.147	1	.284	1.201	.859	1.678
Pedagogical Knowledge	8.366	1	.004*	1.604	1.164	2.209
Active Learning	6.963	1	.008*	1.585	1.126	2.233
Collaboration	2.887	1	.089	1.311	.959	1.791
Support	3.941	1	.047*	1.368	1.004	1.864
Emotional Support	2.552	1	.110	1.278	.946	1.727
Alignment with goals and policies	12.105	1	.001*	1.720	1.267	2.334
Tangible Resources	.224	1	.636	1.079	.787	1.481
Transferability	2.560	1	.110	1.290	.944	1.761
Follow-up	4.314	1	.038*	1.378	1.018	1.866
Duration	1.714	1	.190	1.222	.905	1.651

*$p > .05$

Because the ordinal logistic regression suggested that the independent variable grade level of instruction might have an effect, the researcher conducted an analysis using a continuous variable by tabulating a total score for the importance of the components in

an effective professional development design. As shown in Table 9, there was a statistical significance for elementary versus high school teachers, middle versus elementary teachers, and elementary versus secondary teachers. However, there was not a statistical significance for middle versus high school teachers.

Table 9

Estimates for the Parameters of the Generalized Linear Model for Total Score of Professional Development Component Importance

		Hypothesis Test				95% Wald Confidence Interval for Exp(B)	
Parameter	B	Wald Chi-Square	df	Sig.*	Exp(B)	Lower	Upper
Elementary vs. High	.438	6.795	1	.009*	1.550	1.115	2.155
Middle vs. High	-.037	.037	1	.847	.964	.661	1.405
Middle vs. Elementary	-.475	6.498	1	.011*	.622	.431	.896
Elementary vs. Secondary	.453	9.349	1	.002*	1.574	1.177	2.104

* $p < .05$

When compared to secondary teachers, elementary teachers were more likely to select agree or strongly agree for importance for the inclusion of all components in an effective professional development design (Table 10). Secondary teachers were more likely to select disagree for the importance of all the components, except for collaboration and tangible resources.

Table 10

Percentage of Frequencies for Agree and Disagree of Components in a Professional Development Design by Elementary and Secondary Teachers

	Strongly Agree and Agree		Strongly Disagree and Disagree	
	Elementary	Secondary	Elementary	Secondary
Content Knowledge	85.30	83.09	10.75	11.66
Pedagogical Knowledge	87.81	80.17	7.89	8.75
Active Learning	91.76	86.88	6.81	7.87
Collaboration	80.29	77.55	10.75	10.20
Support	81.36	75.80	10.04	9.33
Emotional Support	65.23	59.18	15.77	19.53
Alignment with goals and policies	73.12	58.02	8.96	15.74
Tangible Resources	84.95	83.67	7.17	4.66
Transferability	82.44	78.72	7.17	6.71
Follow-up	67.03	53.94	13.26	15.16
Duration	59.86	51.90	16.49	22.45

Research question 2d: Interaction between subject taught and Title I status.

To determine if there were a statistically significant interaction effect between the independent variables, subject taught and Title I status of the school, the researcher conducted a three-way repeated measures ANOVA using the total score for professional development importance. There were several outliers in the data, which the researcher assessed as a value greater than three box-lengths from the edge of the box (Figure K1). Because these outliers were unusual data points, and there was no good reason to reject them as invalid, the researcher included them in the analysis. Strength scores were

normally distributed, as assessed by Shapiro-Wilk's test of normality ($p > .05$), except for elementary-STEM-non-Title I teachers, $p = .415$ (Table K1).

Mauchly's test of sphericity indicated that the assumption of sphericity had been violated for the three-way interaction, $\chi^2(2) = 6.822$, $p = .033$. Again, the statistically significant two-way interaction between Title I and grade level of instruction violated the law of sphericity ($p = .001$). Though no data were presented in the Maulchy's Test of Sphericity table, there is an automatic assumption of sphericity for subject taught (STEM and non-STEM) and Title I status of the school (Title I and non-Title I) when there are only two levels (Table K2).

There was no statistically significant three-way interaction between grade level of instruction, Title I status of the school, and subject taught, $F(1.592, 38.197) = .305$, $p = .689$, $\varepsilon = .961$. There was not a statistically significant two-way interaction between Title I status of the school (Title I and non-Title I) and subject taught (STEM and non-STEM), $F(1, 24) = 17.280$, $p = .276$.

Figure 13 shows that it is less likely for there to be a two-way interaction between Title I status of the school (Title I and non-Title I) and subject taught (STEM and non-STEM) for elementary and high school teachers. However, there is a possibility for middle school teachers.

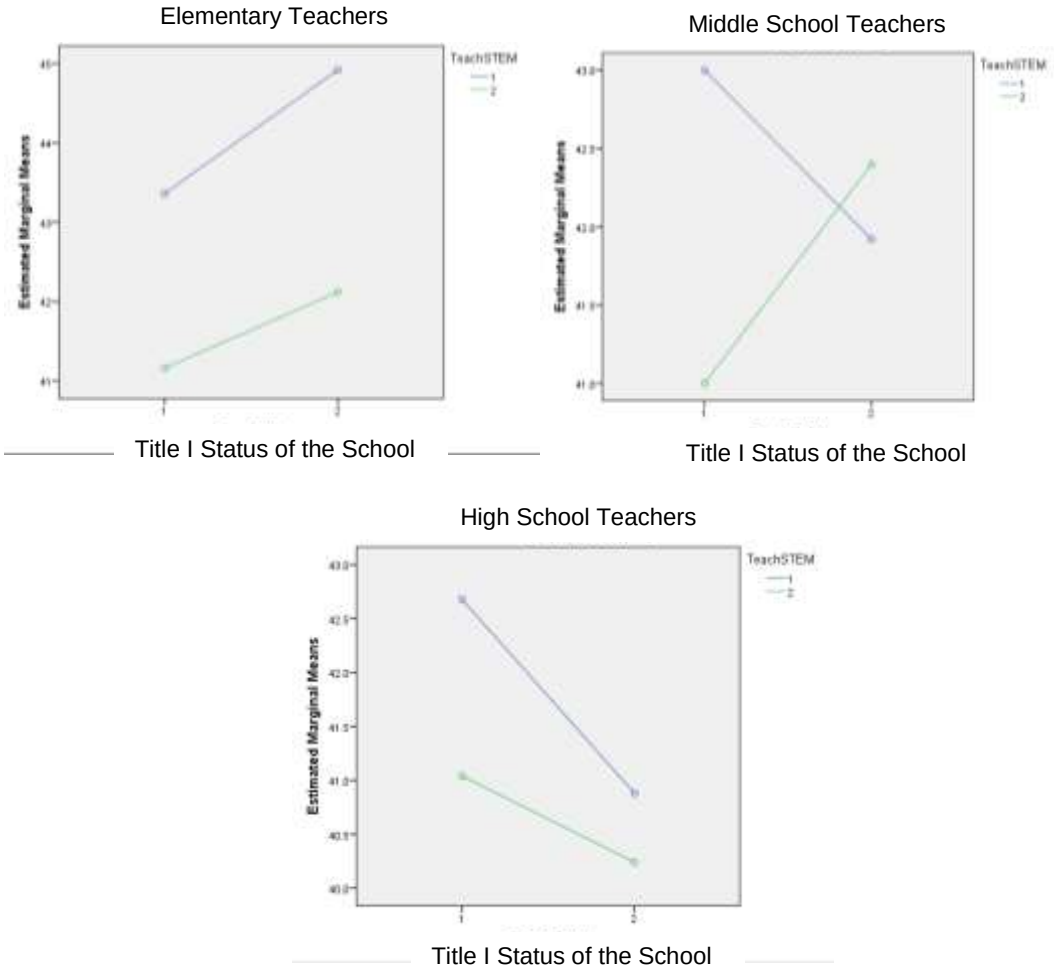

Figure 13. Estimated marginal means of total preferences for professional development design components. TeachSTEM 1 (Yes), 2 (No). Title I status of the school 1 teachers responded yes to the question "Do you teach at a Title I school?" and 2 was a no response.

Final Analysis

The researcher ran an ordinal logistic regression for three questions on the survey that asked teachers if they believed that professional development should look different depending on the subject taught, that professional development should be structured differently for Title I status of the school, and that professional development training should include material that addressed various needs depending on grade level of

instruction. The codes that led to categories and then to themes that arose during the interviews provided the rationale behind the researcher investigating these questions.

Assumptions tests: None of the dependent variables had collinearity. The assumption of proportional odds was not met for grade level needs structure differences, as assessed by a full likelihood ratio test comparing the fit of the proportional odds location model to a model with varying location parameters, $\chi^2(12) = 52.901$, $p = .000$. The same can be stated for Title I needs structure differences $\chi^2(12) = 28.347$, $p = .005$. The assumption of proportional odds was met for structure differences regarding subject taught, $\chi^2(12) = 6.107$, $p = .911$. The researcher ran a binomial logistic regression to check the proportional odds for the two dependent variables that did not meet the assumption of proportional odds with the full likelihood ratio test. Again, these two variables failed to meet this assumption. For this reason, the researcher addressed only the question pertaining to professional development training looking different depending on the subject taught.

The deviance goodness-of-fit test indicated that the model was a good fit for the observed data, $\chi^2(40) = 37.746$, $p = .572$. The final model did not statistically significantly predict the dependent variable over and above the intercept-only model, $\chi^2(4) = 7.109$, $p = .130$. The odds ratio of being in a higher category of the dependent variable for teachers at Title I schools versus non-Title I was 1.235, 95% CI [.912, 1.672]: not a statistically significant effect, $\chi^2(1) = 1.863$, $p = .172$. The odds of STEM teachers considering that professional development should be structured differently for subject taught was 1.273, 95% CI [.936, 1.733] times that of non-STEM teachers – not a statistically significant effect, $\chi^2(1) = 2.365$, $p = .124$.

For high school teachers, the independent variable, grade level of instruction did not have a statistically significant effect on the researcher's prediction of whether there should be structural differences in professional development trainings depending on subject taught, Wald $\chi^2(1) = 2.003$, $p = .367$. The odds of middle school teachers strongly agreeing with structural difference in professional development based on subject taught was .763, 95% CI [.508, 1.145] times that of high school teachers: not a statistically significant effect, Wald $\chi^2(1) = 1.709$, $p = .763$. The odds of elementary teachers versus high school teachers (odds ratio of .974, 95% CI [.681, 1.391], Wald $\chi^2(1) = .022$, $p = .883$) and elementary versus middle school teachers (odds ratio of .718, 95% CI [.489, 1.055], Wald $\chi^2(1) = 2.852$, $p = .091$) were similar to that of middle versus high school teachers.

During the interviews, the category, lack of differentiation and not appropriately leveled emerged (Figure 7); this connected to three questions on the survey. These questions asked teachers if they believed that the structure of professional development should address the specific needs of Title I schools, the structure of training should look different depending on subject taught, and professional development should include material that addresses the needs of grade level instruction. For the independent variables investigated -- subject taught, Title I status of the school, and grade level of instruction -- over 80 percent of teachers responded agreed or strongly agreed that professional development should be structured accordingly (Figures 14-16).

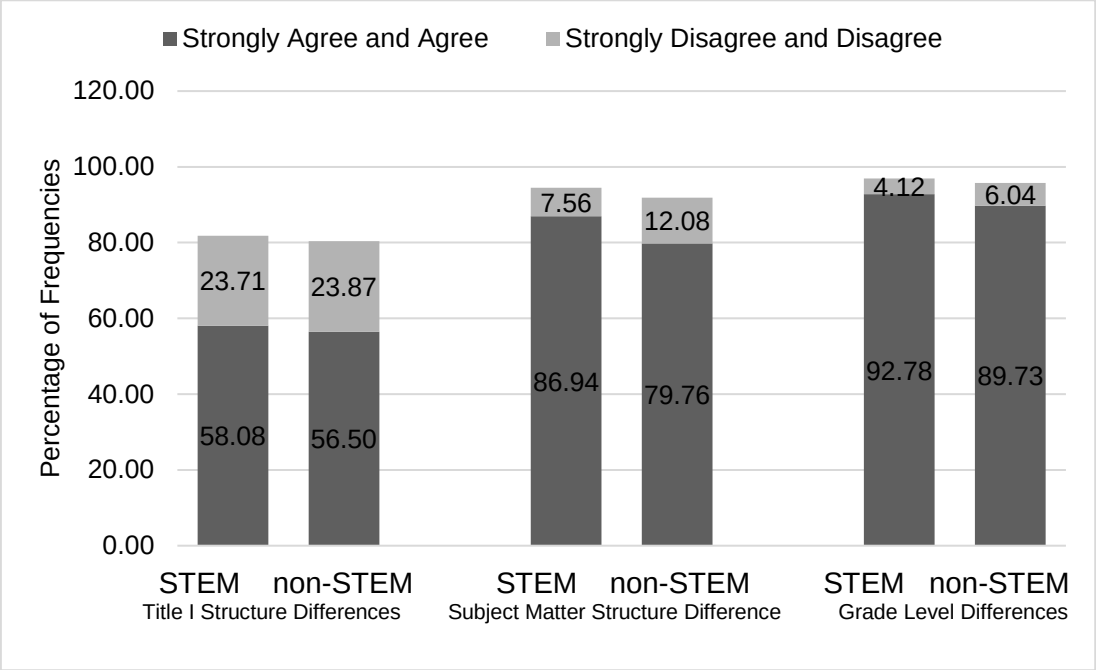

Figure 14. STEM versus non-STEM percentage of agreement and disagreement to Title I, subject matter, and grade level structural differences in professional development.

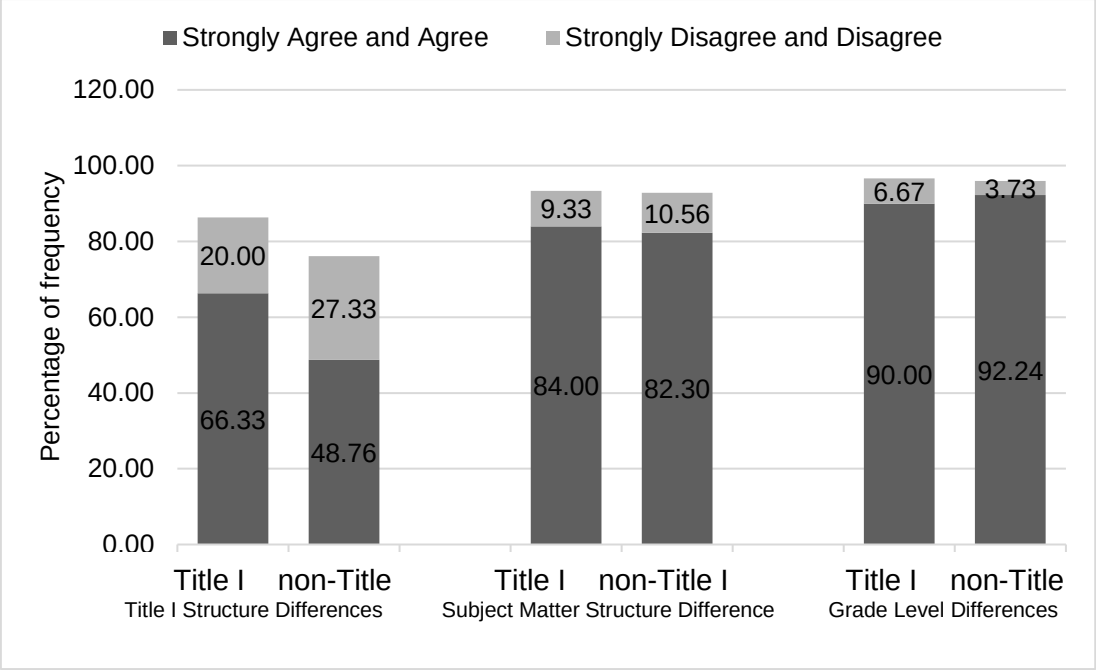

Figure 15. Title I versus non-Title I percentage of agreement and disagreement to Title I, subject matter, and grade level structural differences in professional development.

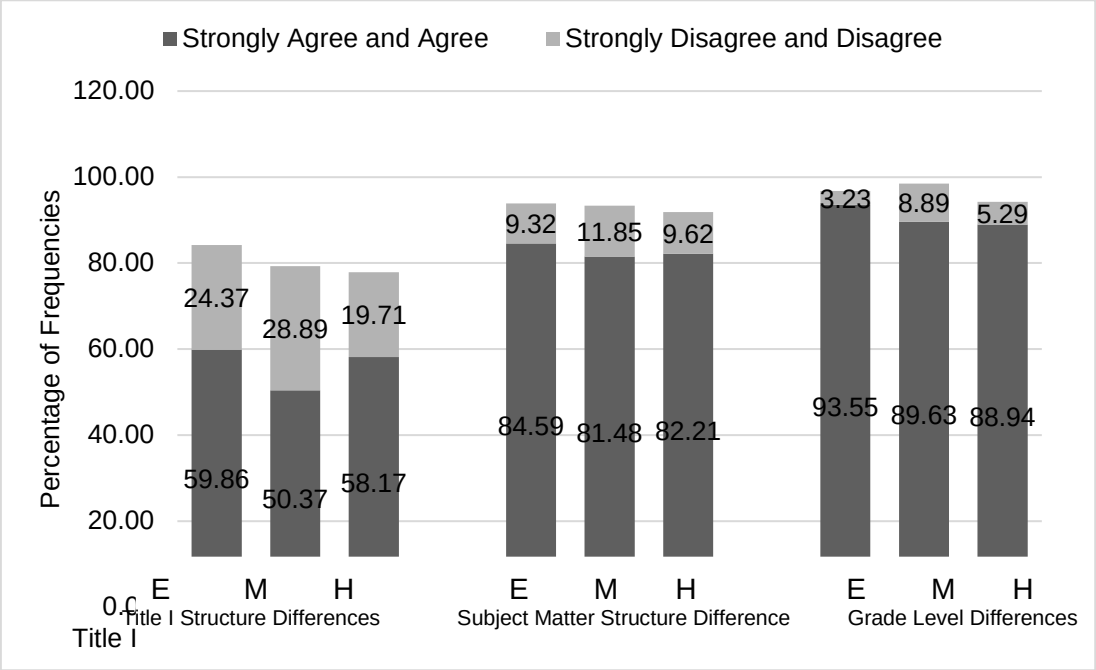

Figure 16. Grade level of instruction percentage of agreement and disagreement to Title I, subject matter, and grade level structural differences in professional development. Elementary (E), Middle (M), and High (H) school teachers

Chapter Summary

After investigating if factors such as subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influenced teachers' preferences regarding the components included in an effective professional development design, research has yielded several important results.

The components that the researcher selected were apparent in the interview data. STEM teachers, teachers at Title I schools, and high school teachers mentioned the components, content knowledge, active learning, pedagogical knowledge, alignment with goals and policies, collaboration, follow-up, tangible resources, transferability, and duration more frequently during interviews. This provided reliability to survey questions regarding the components selected. Two more themes arose from the data: perceived a

priori components in an effective professional development design, and other constituents for the overall professional development structure. The researcher used these themes to provide dimensionality in the discussion and implication sections of this study.

The ordinal logistic regression indicated that subject taught and Title I status of the school did not have a statistically significant effect on the dependent variable. For grade level of instruction, when broken into elementary and secondary, there was a statically significant effect on teachers' preferences regarding components included in an effective professional development design.

To see if there were any interaction between subject taught and Title I status of the school, the researcher conducted a three-way repeated measures ANOVA. There was no statistically significant three-way interaction between subject taught, Title I status of the school, and grade level of instruction. Likewise, there was no statistically significant two-way interaction between Title I status of the school (Title I and non-Title I) and subject taught (STEM and non-STEM) for total importance of preferences regarding components in an effective professional development design $F(1, 24) = 17.280$, $p = .276$.

V. DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

The purpose of this study was to investigate if subject taught, Title I status of the school, and grade level of instruction influenced teachers' preferences regarding components in an effective professional development design. The study was also used to determine whether the components in an effective professional development design should be different based on subject taught (STEM versus non-STEM), Title I status of the school (Title I versus non-Title I), and grade level of instruction (elementary, middle, or high). Lastly, the researcher's rationale for conducting this research was to show inconsistencies within the one-size-fits-all model of professional development. Experts in the field have used research that Guskey (2003) referred to as, "inconsistent and sometimes contradictory" (p. 749). The researcher's goal was to question this model by showing that professional development should be differentiated based on grade level of instruction, Title I status of the school, and subject taught.

The literature for professional development provided many choices/components that could be included in an effective professional development design; Guskey (2003) identified 21. With this many components to choose from, the researcher selected nine to use in this study. This included content knowledge, pedagogical knowledge, active learning, collaboration, support, resources (tangible and intangible), follow-up, alignment with goals and policies, and duration. The researcher first conducted interviews to determine teachers' perceptions of an effective professional development design. A key finding indicated that regardless of the grade level teachers taught, they mentioned the

same nine components that the researcher selected. Not all of the professional development trainings that the teachers described were district or school site trainings. When describing the trainings that occurred at the school site or at the district, often, the components, active learning (the hands-on experience that helps the learner) and transferability (bringing back to the classroom; relatability) were linked with negative responses because they were not part of the trainings. The absence of these components could be part of the reason for teachers' disgruntled attitudes toward professional development.

In the statistical analysis, there was violation of some of the assumptions. Not all of the data aligned with statistical assumptions for the ordinal logistic regression and the three-way repeated measures ANOVA. For this reason, the researcher used most of this study as an exercise in research. After the researcher investigated the statistical significance of subject taught (STEM and non-STEM), Title I of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high), findings showed that only grade level of instruction had a statistically significant effect on the total score of importance for components in an effective professional development design. Title I status of the school (Title I versus non-Title I) influenced the component collaboration, thus failing to reject the null hypothesis: Title I status of the school (Title I versus non-Title I) influences components included in an effective professional development design significantly.

Grade level of instruction (elementary, middle, high) did not have a statistically significant effect on teachers' preferences regarding components included in an effective professional development design. However, when middle and high school were

combined, the researcher did not reject the null hypothesis. Since grade level of instruction influenced teachers' preferences regarding components in an effective professional development design, the researcher examined the interaction between subject taught and Title I status. Unfortunately, the null hypothesis -- The difference between STEM and non-STEM teachers' preferences regarding components included in an effective professional development design is not a significant function of Title I status of the school (Title I and non-Title I) – was rejected.

Though the ordinal logistic regression showed a lack of statistical significance, percent differences calculated by the frequency, divided by the total in each group, indicated that factors such as subject taught, Title I status of the school, and grade level of instruction influenced teachers' preferences for specific components in an effective professional development design. However, the researcher would have to use a much larger sample to fully explore the research questions.

Discussion

What are perceptions of effective professional development design components among K-12 school teachers in a large public-school district located in the southeastern part of the United States?

Based on some of the findings from the interviews, a clearer picture of what teachers believed professional development should be like versus what it is really like started to emerge. The researcher needs to augment findings from this study with a larger study to accurately determine teachers' perceptions of components included in an effective professional development design. During the interviews, when the researcher asked teachers to describe a professional development they had participated in, several

were unable to answer this question fully without the researcher probing them. Some of the probing questions included one of the effective components, creating a situation in which the interviewee may not have mentioned the component if not for the pointed questions. Even though this was the case, the interviews provided the data needed for the purposes of this research study as well as some insight into the professional development designs offered to teachers.

Teachers were asked to describe a professional development training they attended. The teachers who chose to describe a training that was not district or school-run, when compared with teachers who described a district or school site training, included more of the components that the researcher selected. When the researcher gave teachers each component and asked if the professional development training they had attended at their school site or district included or did not include the specific component, it was much easier for teachers to describe their experiences. Figure 17 showed that majority of the participants responded affirmatively to the components the researcher selected as part of the professional development design.

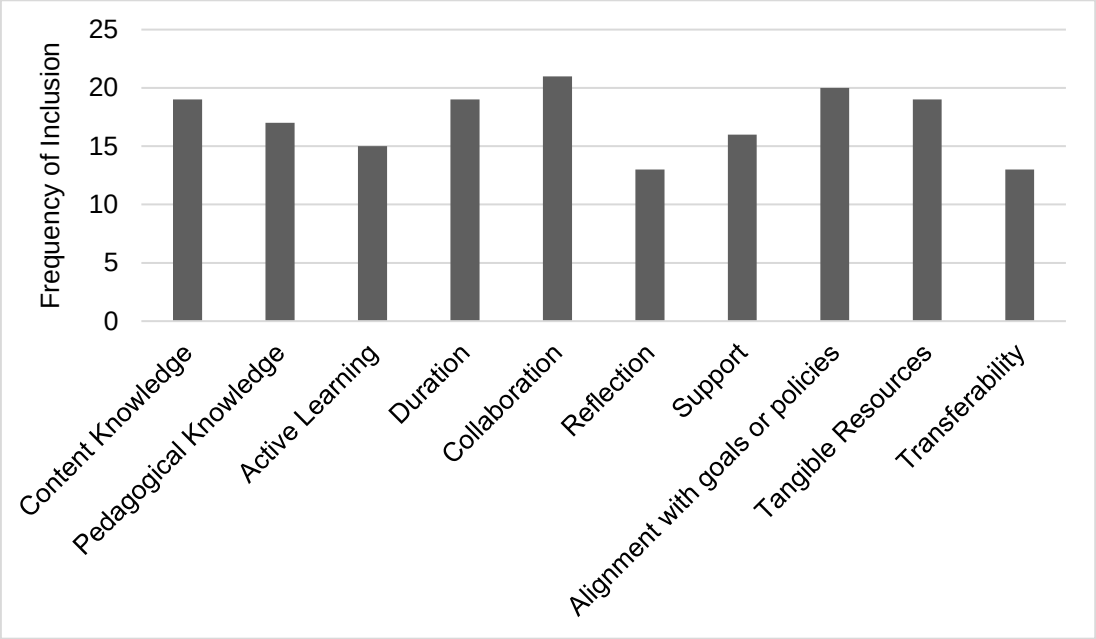

Figure 17. "Yes" responses for the final question on the interview protocol.

Teacher autonomy for professional development sessions and transferability.

The category, "sessions" (nested in the theme, "other constituents for the overall professional development structure") emerged as teachers indicated their preferences for attending professional development that revolved around topics they were interested in. When teachers gained the ability to choose which sessions they wished to attend, they became more likely to bring material taught in professional development back to their classrooms. One participant said, "I think when you attend the professional development that you want to go to, it is different than to the ones that you have to go." This participant went on to describe how the sessions she selected taught her "strategies that [could] help [her to] enhance the teaching and help [her] students." A high school teacher stated that at her school site, "they do a bunch of workshops for introducing new tools and things to use in the classroom." Being able to bring the knowledge gained in

professional development back to the classroom (otherwise known as relatability) was the component, transferability.

Teachers were less likely to indicate that the component, transferability was included in their training (Figure 17). This could be the rationale for some teachers' negativity toward school and district professional development trainings, which was one of the themes that arose during the interview process. Teachers stated:

- "I think the problem with [professional development] is that it ends up not being relevant to what myself and the other teachers [are] doing."
- "I just think that the more you can get that is useful in the classroom it helps."
- "I wish that we would have more realistic professional developments."

Not all the responses were negative. When referring to the overall quality of professional development trainings within her district, one teacher commented, "I would say the district does a good job." Another teacher said, "We did some rotations and there was one that was a little different that everyone actually enjoyed." This teacher was referring to an activity conducted at the school site where teachers were able to write down topics of interest and then sessions were created based on these topics. The way the professional development was structured for this teacher stressed the transferability component, which could be the reason for the fact that teachers enjoyed this training. There might be a link between the component, transferability and teachers' high level of satisfaction with the professional development training. Likewise, there might be a link between teachers' ability to select the sessions they wish to attend, and an increase in the likelihood of them bringing the material they learn in these sessions back to the

classroom. The researcher would have to gather more information to determine if there is, in fact, a connection.

Active learning and teachers' satisfaction with professional development. Another component that the researcher observed in conjunction with negative comments was active learning. In describing the professional development trainings that occurred at a school site, and after commenting that most of the trainings consisted of PowerPoint presentations, the same teacher said:

> [I]t is easy to forget the information that you have learned. Which makes it very difficult. Because, then it feels like you are just wasting your time. Yah, you'll pick up tidbits here and there that you'll try and find out which ones are effective. Without actually seeing it in motion and seeing it modeled, they're not very effective.

Failure to include the component, active learning (hands-on experience that helps the learner) was linked with teachers' negative responses regarding professional development trainings. For example, teachers called these trainings "irrelevant" or "a waste of time." After summarizing the literature about active learning, Bonwell and Eison (1991) wrote that active learning's presence in professional development could lead to better student attitudes and ultimately, improve student learning. If these trainings contained built-in active learning, negative comments such as these might decline in frequency. In order to determine if there were a link between relevance and active learning, the researcher would have to investigate the topic further.

New versus veteran teachers: Future study. During the interviews, the category, lack of different levels emerged. The researcher first connected this with the

independent variable, grade level of instruction. Upon further investigation, the researcher found that this category referred to teaching experience; new versus veteran teachers, not grade level of instruction differentiation. Not having different levels for the new versus veteran teachers made the professional development irrelevant for some teachers. The idea of offering professional development based on years of experience is not one that the researcher focused on in this study but does lend itself to a future study.

Research question 1 summary. It appears that subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high) influence teachers' perceptions regarding components included in an effective professional development design. Because interviews from one Title I elementary teacher and a middle non-STEM Title I teacher were missing, the researcher is cautious about making sweeping statements.

Teachers understood the importance of professional development, but they were also able to point out some of the flaws that still existed in the design. They believed that all of the components included in an effective professional development design should be ones that the researcher selected. However, not all of the trainings teachers received included all of the components. Some professional development designs lacked active learning and transferability. These two components may be linked to teacher satisfaction, and may be linked conjointly. Teachers were more likely to bring professional development that included active learning back to their classrooms.

The interviews provided some insight into what teachers experienced in their professional development regarding structure and elements that were lacking. These were interesting findings from the interviews and require further investigation. For the

purposes of this research study, the interviews that the researcher conducted allowed her to determine that the components chosen were, in some form, part of teachers' professional development trainings, and provided reliability to the component questions on the survey.

Does subject taught (STEM and non-STEM) influence preferences regarding components that should be included in an effective professional development design?

The Bill & Melinda Gates Foundation Study, *Teachers know best: Teachers' views on professional development* (2014) stated that when asked what effective professional development looked like, teachers were able to provide a description. There are several research studies that showed that the inclusion of specific content knowledge in professional development can increase teachers' basic knowledge in specific subjects, help teachers develop activities for instruction, and enhance teachers' ability to facilitate learning in the classroom (Mattheis et al., 2015; Roth et al., 2011; Seraphin et al., 2013). Using the research as a foundation, it made sense to structure professional development based on teachers' needs, which varied according to the different subjects they taught.

On the survey, the researcher asked whether participants agreed with the statement, "The structure of a professional development training should look different depending on the subject matter taught (STEM and non-STEM)." The majority of teachers -- elementary (84%), middle (81%), high (82%) – agreed that this should be the case. Teachers also agreed that professional development should look different depending on the subject taught, but in order to determine what the differences in

professional development should be, the researcher had to analyze the individual components.

The percentage of participants who answered agree or strongly agree to the survey statement, “For me (component and definition) is an important aspect of a professional development design” reflected that overall, both STEM and non-STEM teachers agreed that the components literature states are part of an effective professional development design are, indeed, important (Figure 18). Three components had greater than five percent difference for STEM (n = 291) versus non-STEM (n = 331) teachers: content knowledge (5.37%), alignment with goals and policies (6.75%), and duration (5.55%). These differences start to show that subject taught possibly influences teachers’ preferences for components in an effective professional development design.

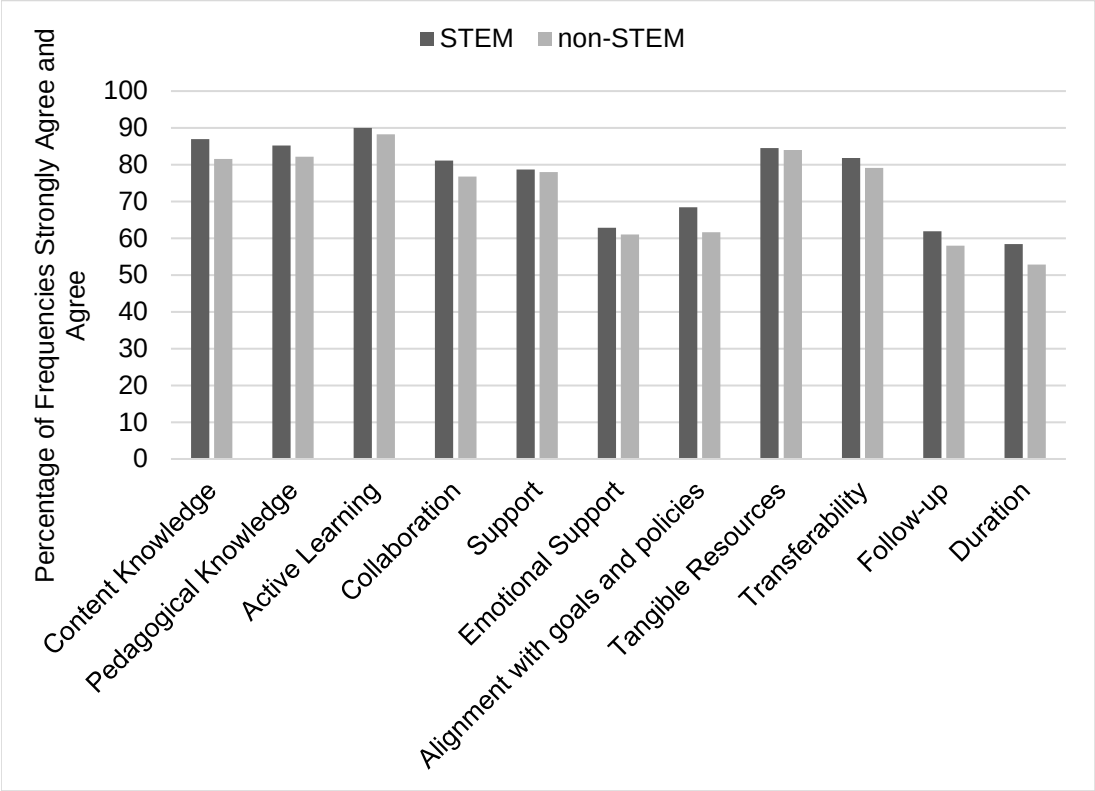

Figure 18. Percentage of frequencies for agree and strongly agree of components by STEM and non-STEM teachers.

Non-STEM teachers agreed more often than STEM teachers that content knowledge, collaboration, and tangible resources were an important component to include in their professional development design. Results from the statistical analysis showed that subject taught did not have a statistically significant effect on the components the researcher selected when divided by STEM and non-STEM teachers. The null hypothesis for this research question was rejected.

After rejecting the null hypothesis for each component, the researcher tabulated a total score for the component questions on the survey to help determine the overall effect that subject taught had on teachers' preferences regarding components included in an effective professional development design. Statistical analysis revealed that subject

taught did not have a statistically significant effect (p = .546) on components included, indicating that there does not need to be differentiation of professional development based on subject taught.

The percent differences for components are minimal. Likewise, between educators who teach science, technology, engineering, and/or mathematics courses and educators who teach courses in all other core subjects, there is no statistical significance for each component. Thus, in conclusion, differentiating professional development based on subject taught appears to be unnecessary. These results hint that teachers' needs based on subject taught are not the source of teachers' disgruntled attitudes toward professional development. Because the statistical analysis did not align with the assumptions and the researcher used it as an exercise in practice, one might consider these findings inconclusive until the researcher can conduct a deeper investigation using a larger sample.

What are the differences, regarding preferences for components that should be included in an effective professional development design, between the teachers at Title I schools and teachers at non-Title I schools?

Schools receiving Title I funds must devote sufficient resources to effectively carry out high quality and ongoing professional development for teachers (Elementary and Secondary Education Act, 1965). The federal policy mandates that states, "set aside 10% of their [Title I fund] allocations for school-wide professional development" (Wei et al., 2009, p. ii). Extra funding and the higher percentage of students on free and reduced lunch at Title I schools may have created a difference between Title I teachers'

professional development component preferences and non-Title I teachers' professional development component preferences.

When asked to agree or disagree with the statement, "Professional development training should include material that specifically addresses the needs of Title I schools," 66 percent of Title I (n = 300) teachers and 49 percent of non-Title I (n = 332) teachers agreed, indicating that non-Title I teachers do not think that professional development trainings need to be differentiated based on a school's Title I status. To see if non-Title I teachers were vindicated, the researcher analyzed each component to determine if professional development should be differentiated based on a school's Title I status.

Overall, teachers at Title I and non-Title I schools agreed that the components the researcher selected were an important aspect of a professional development design. Title I teachers were more likely to agree that alignment with goals and policies (8.7%) and follow-up (8.10%) should be included in an effective professional development design, whereas non-Title I teachers indicated that collaboration (6.5%) was more important to them in the overall design (Figure 19). These differences signify that there might be a need for differentiating professional development based on a school's Title I status. There has been little research on the benefits of professional development within Title I schools. However, one study reveals that when teachers praised professional development that was "geared to the standards and assessments; and active communication between school and home" (p. 24), students demonstrated increases on a national mathematics assessment (Westat & Policy Studies Associates, 2001). This gave some merit to the differences exhibited in the component agreements and Title I teachers'

positive responses regarding professional development trainings that meet their specific needs.

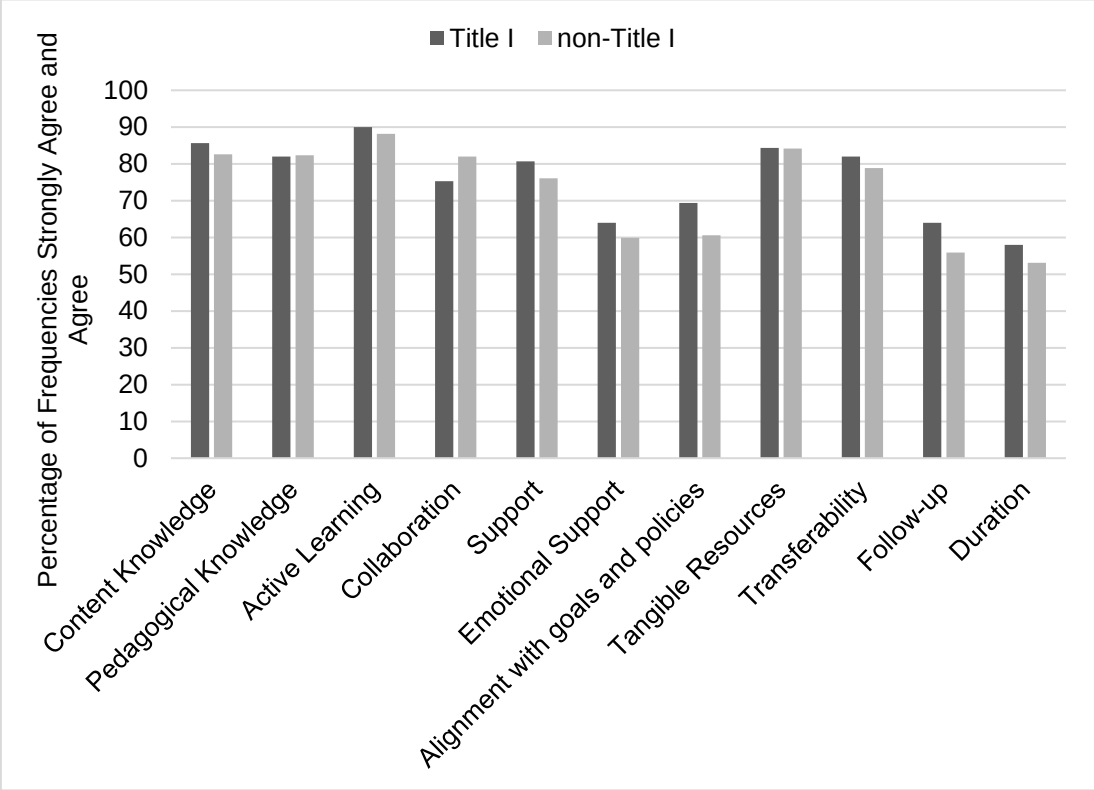

Figure 19. Percentage of frequencies for agree and strongly agree of components by Title I and non-Title I teachers.

Only one component showed statistical significance for Title I versus non-Title I: collaboration. The percentage of the frequencies confirmed that non-Title I teachers were more likely to agree that collaboration was an important aspect of their professional development design. A possibility behind this finding could be that Title I schools are provided with "extra resources to help high-poverty schools meet the greater challenges of educating disadvantaged students" (United States Department of Education, 2011, p. 2). These extra resources come in the form of professional development for teachers, extended school times, and material supplemental to the curriculum, to name a few. Part

of receiving these extra resources is that professional development is mandated. In the district that the research was conducted within, in order to receive extra resources, Title I schools were required to conduct learning team meetings or professional learning communities (PLCs), as well as professional development. The lack of extra resources (no mandated professional development or PLCs) could be the reason why non-Title I teachers felt that collaboration was an important part of their professional development design.

In conclusion, the researcher failed to reject the null hypothesis. Title I status of the school (Title I versus non-Title I) significantly influenced a component – collaboration – included in an effective professional development design. If one were to ask if professional development design should be differentiated based on Title I status of the school, the answer would be no. Title I status of the school did not have a statically significant effect (p = .177) on the total score of component importance. Once again, it appears that teachers' expression of dissatisfaction with professional development is not due to a lack of differentiation based on Title I status of the school. The researcher would have to investigate further to determine if this analysis is accurate because this study was used as a practice in research.

What are primary and secondary teachers' preferences regarding which components are part of effective professional development design?

In *What Works in Professional Development?,* Guskey and Yoon (2009) described a major study that used the What Works Clearinghouse (a branch of the United States Department of Education) criteria to investigate 1,300 research studies that addressed effective professional development. Of these studies, only nine met the criteria

and “all nine studies focused on elementary schools and were conducted between 1986 and 2003. No studies of professional development at the middle school or high school levels met the [What Works Clearinghouse] WWC standards, nor did any of the studies published between 2004 and 2006” (Guskey & Yoon, 2009, p. 496). With this knowledge, creators of professional development have continued to develop trainings based on elementary-focused research, even though there are multiple research studies that have shown that individuals do not learn in the same way (Fischer & Rose, 2001; Green, 1999; Mulroy & Eddinger, 2003; Tomlinson & McTighe, 2006). This gives rise to the question: Why is the same professional development design delivered to the different grade levels of instruction?

After investigation of the components the elementary (n = 279), middle (n = 135), and high (n = 208) school teachers agreed or disagreed were an important aspect of the professional development design, several important findings surfaced. The first part of this investigation broke grade level of instruction into elementary, middle, and high school to determine if there were differences between these three levels. For the second part of this investigation, the researcher split grade level of instruction into elementary (n = 279) and secondary (n = 343) teachers.

When compared to middle school teachers, elementary teachers agreed more frequently that pedagogical knowledge (10.04%), active learning (8.79%), support (7.29%), emotional support (7.46%), alignment with goals and policies (10.16%), transferability (7.62%), and follow-up (16.65%) were important components to include in a professional development design. On the other hand, middle school teachers disagreed that duration (6.48%) was an important component in the design (Figures 20 and 21).

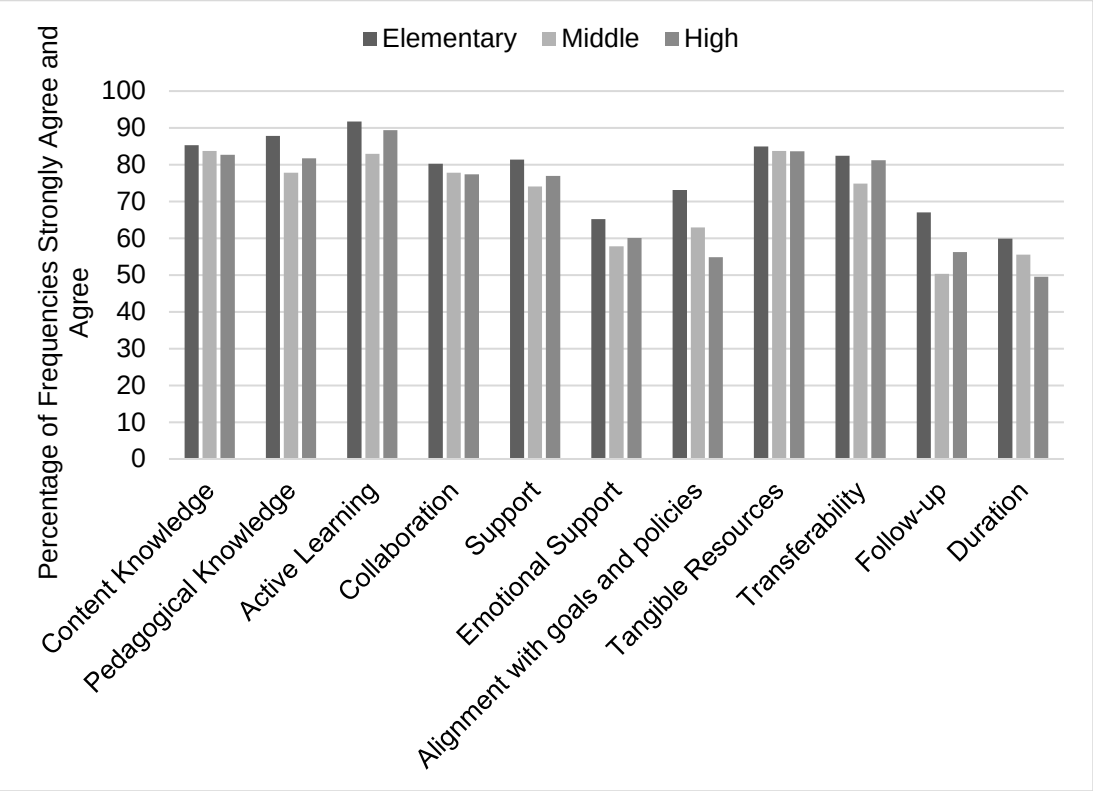

Figure 20. Percentage of frequencies for agree and strongly agree of components by elementary, middle, and high teachers.

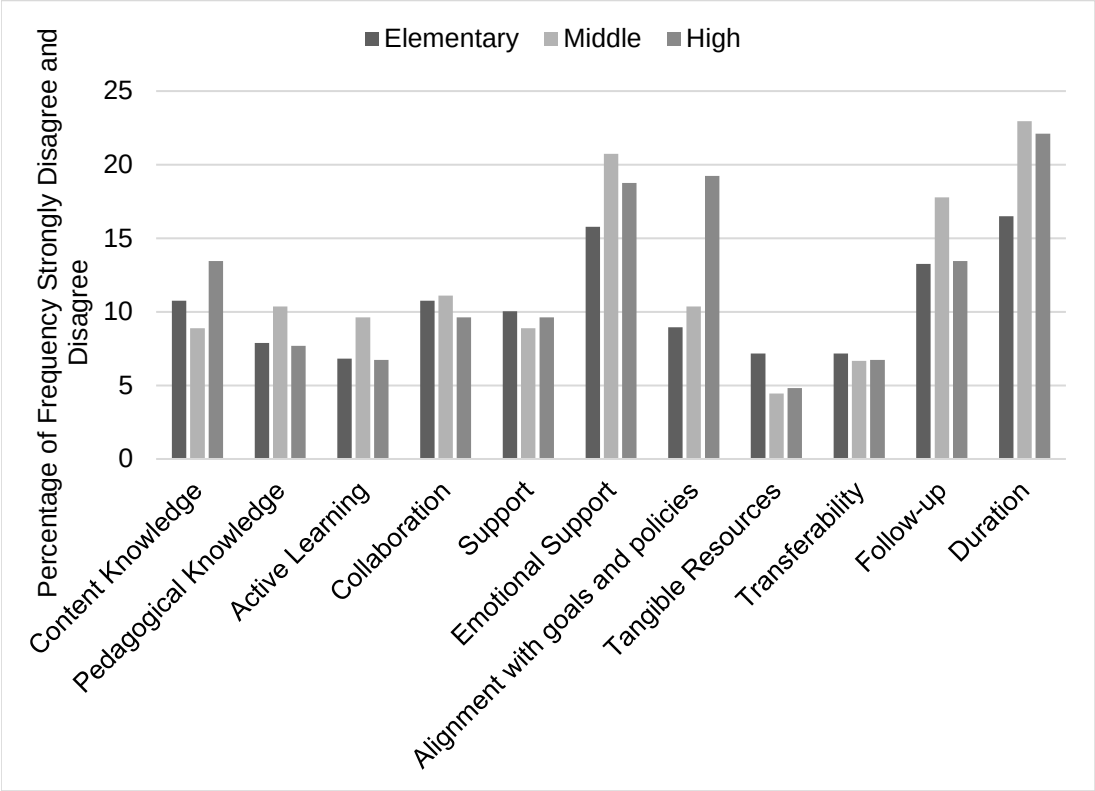

Figure 21. Percentage of frequencies for disagree and strongly disagree of components by elementary, middle, and high teachers.

When comparing elementary to high school teachers, elementary teachers again were more likely to agree that pedagogical knowledge (6.08%), emotional support (5.14%), alignment with goals and policies (18.31%), follow-up (10.78%), and duration (10.34%) were important aspects of the design. Compared to elementary teachers, high school teachers were more likely to disagree that alignment with goals and policies (10.27%) and duration (5.63%) were important to include in a professional development design (Figures 20 and 21). The differences in agreement and disagreement between elementary and high school teachers for components was excepted; grade levels are divided based on ages, and cortical function (i.e. reading, writing, cognition, memory, behavior) becomes fine-tuned with age (Casey, Tottenham, Liston, & Durston, 2005).

This creates a difference in what teachers need from professional development in order to better instruct their students.

There were differences between middle school teachers and high school teachers regarding agreement and disagreement with the importance of certain components. High school teachers agreed that active learning (6.46%), transferability (6.44%), and follow-up (5.88%) were important components, but disagreed that alignment with goals and policies (8.86%) was an important component. Middle school teachers denoted more frequently that alignment with goals and policies (8.16%) and duration (6.04%) was important to them (Figures 21 and 22). The researcher utilized the differences between the percentage of frequencies for responses, a divergence between the grade levels started to appear. This divergence, combined with statistical analysis showing grade level of instruction's significant effects on specific components, could possibly account for some of teachers' disgruntlement towards professional development. This disgruntlement might indeed stem from a lack of differentiation based on grade level of instruction. This study showed that differentiation based on grade level of instruction must be implemented. Thus, researchers will have to conduct a study in order to investigate more in depth whether lack of differentiation based on grade level of instruction causes teacher dissatisfaction.

Some interesting data arose when the researcher analyzed the components based on grade level of instruction: elementary, middle, and high. Only four of the components did not violate the overall omnibus statistical test: pedagogical knowledge, alignment with goals and policies, active learning, and transferability. Elementary teachers were more likely than high school teachers to agree that the components, pedagogical

knowledge and alignment with goals and policies should be a part of a professional development design. However, when compared to middle school teachers, elementary teachers were almost half as likely. This could be because when compared to elementary teachers, middle school teachers -- at least mathematics and science teachers -- may feel more confident in their pedagogical knowledge, as the National Survey of Science and Mathematics Education (NSSME) (2012) indicated that professional development provided ample pedagogical knowledge. This, in combination with the time teachers must spend in professional development, "roughly 30 percent of middle and high school science and mathematics teachers, and far fewer of their elementary colleagues, participated in more than 35 hours" (Banilower et al., 2013, p. 34), gives some merit to middle school teachers' pedagogical knowledge confidence.

Elementary and middle school teachers had a statistically significant effect on the component, active learning. However, once again, the odds of middle school teachers agreeing that active learning was an important aspect of their professional development design were about half that of elementary teachers. The researcher would have to conduct a deeper investigation of this specific component in order to determine why this was so.

One of the final questions in the survey asked teachers if, "professional development training should include material that specifically addressed the needs of grade level of instruction." The percentage who answered agreed or strongly agreed was about the same for middle (90%) and high (89%); elementary teachers agreed more frequently (94%). This indicates that teachers in every grade level felt that professional development should be differentiated based on grade level of instruction. To determine if

preferences of components by grade level of instruction had statistical significance, the researcher used the total score of importance. Between elementary and middle school teachers (p = .004), there was a statically significant effect. The statistical significance correlated with several components that elementary versus middle school teachers had significance for. Likewise, there were percentage differences. For elementary versus high, there was not a statically significant effect (p = .760); the same applies to middle versus high (p = .341).

When grade level of instruction was divided by elementary and secondary, there were more components that had statistical significance. For pedagogical knowledge, active learning, support, and follow-up, elementary teachers were almost one-and-half times more likely to agree that these components are an important aspect of the professional development design. Elementary teachers were almost twice as likely as secondary teachers to agree that the component, alignment with goals and policies was important. When the researcher totaled the components score, grade level of instruction (elementary versus secondary) had a statistically significant effect (p = .002); this indicates that grade level of instruction does influence components in an effective professional development design. Thus, failing to reject the null hypothesis.

In conclusion, half of the components the researcher selected showed that grade level of instruction, when divided by elementary and secondary, had statistically significant effects on each of these components. This exhibits that there are differences in teachers' preferences regarding the components in the professional development design for elementary and secondary teachers. Once again, the researcher cannot reject

the null hypothesis. Future researchers must follow the analysis the researcher conducted for this study with a study that has a greater response rate in order validate these findings.

Are the differences in the components of the professional development design between STEM and non-STEM teachers a function of the Title I status of the school (Title I and non-Title I)?

Federal policies like the America COMPETES Reauthorization Act of 2010 made $9.3785 billion available for the National Science Foundation (NSF) (§503). The NSF is charged with overseeing most of science, technology, engineering, and mathematics education and professional development. Also, a technical report, *Professional Learning in the Learning Profession: A Status Report on Teacher Professional Development in the U.S. and Abroad* (2009) revealed that teachers' perceptions of the usefulness of professional development varied, depending on the topic addressed. When the professional development focused on the content educators taught, 60.9 percent of teachers at schools that were greater than 53.8 percent free or reduced lunch found training useful (Wei et al., 2009). With large amounts of funding coming from the federal government for STEM education, Title I's mandates for professional development, and research showing how teachers find content-focused professional development most useful, created an opportunity for the researcher to see if there were an interaction between STEM, Title I, and grade level of instruction.

Unfortunately, the researcher did not find a statistically significant three-way interaction. Thus, a school's Title I status' (Title I versus non-Title I) effect on components of the professional development design proved not to be dependent on the subject taught (STEM and non-STEM) or grade level of instruction (elementary, middle,

high). For the purpose of this study, the researcher rejected the null hypothesis for grade levels – elementary and high school teachers. The difference between STEM and non-STEM middle school teachers' preferences regarding components included in an effective professional development design is a significant function of Title I status of the school (Title I and non-Title I). Thus, again, the researcher could not reject the null hypothesis. Due to the statistical analysis not passing all the assumptions, these findings are inconclusive.

Implications and Recommendations

The purpose of this research study was to twofold: first, to determine if subject taught, grade level of instruction, and Title I status of the school influenced teachers' preferences regarding components included in an effective professional development design; second, to determine if professional development should be differentiated based on subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary, middle, and high). The researcher acknowledged that there are several limitations to this study. The response rate was very low. This eliminated the possibility of generalizing the findings. The assumptions did not validate all of the statistical analyses, making most of the results un-publishable. This project lent itself to a larger data sample to more thoroughly examine whether subject taught (STEM and non-STEM), Title I status of the school (Title I and non-Title I), and grade level of instruction (elementary and secondary) influenced preferences regarding components included in an effective professional development design.

Professional Development

The researcher has investigated the benefits of professional development bountifully. Research has shown that when professional development is focused on instructional practices and includes active learning, there is a positive effect on teachers' instruction (Desimone, Porter, Garet, Yoon, & Birman, 2002). Teachers who had undergone more than 14 hours of professional development training had a positive effect on student achievement (Yoon et al., 2007). Despite all of the benefits that professional development has proven to provide, there are several reasons why teachers find professional development to be irrelevant, ineffective, and disconnected from content (Bill & Melinda Gate Foundation, 2014), and several adjustments that must be made. First, professional development needs to be differentiated based on grade level of instruction. This study showed that the one-size-fits-all model is not appropriate for all levels of instruction. Secondly, when the professional development design lacks the component, active learning, teachers are less likely to bring professional development material back to their classroom. Third, teachers feel that if the professional development is not relevant or does not include the component, transferability, professional development is a waste of their time. Lastly, the professional development design needs to include all of the components selected for this study (content knowledge, pedagogical knowledge, active learning, collaboration, flow-up, tangible resources, alignment with goals and policies, duration, support, and transferability). That being said, certain components should be emphasized according to the target audience.

This study's implications apply to the following groups: teachers, school administrators, teacher educators, curriculum developers, and policy makers.

Teachers. The main aim in this study was to address the almost complete lack of research-based evidence of teachers' preferences regarding which components should be included in an effective professional development design. The researcher examined teachers' preferences by interviewing and surveying the teachers at a large public school district located in the southeastern United States. She placed special attention on determining if the subjects these teachers taught, their schools' Title I statuses, and the grade level they instructed influenced their component preferences. The first implication of this study is that teachers' grade level of instruction does influence their component preferences. This is important; often, schools or districts make sweeping changes that necessitate professional development, but the professional development they provide is not always appropriate for all grade levels. The data from a larger study by Wei et al. (2010) is comparable in that researchers asked teachers about the usefulness of professional development. Instead of looking at the structure of the professional development, the researchers investigated topics within the professional development (use of technology, English Language Learner, etc.). The factors researchers took into consideration included school level, urbanicity, minority enrollment, free/reduced lunch, and limited English proficiency (Wei et al., 2010). The division of the teacher population in this study was similar to the independent variables that the researcher investigated.

The second implication of this study applies to teachers who are in charge of the professional development at their schools. The data collected in this study provides each teacher with a guide regarding which component he/she should emphasize more depending on the characteristics of his/her school. As reflected in Figure 22, teachers who provide professional development at a non-Title I elementary school should include

all components (content knowledge, active learning, pedagogical knowledge, collaboration, follow-up, tangible resources, alignment with goals and policies, transferability, duration, and support), but place more emphasis on alignment with goals and policies, duration, and collaboration.

There is one study in which researchers investigated the usefulness of professional development that involves component support, content knowledge, and active learning (Wei et al., 2009). Another phenomenological study that LaNysha Adams (2014) conducted explored how teachers at a Title I high school perceive their professional development experience. Differentiating based on subject taught, Title I status of the school, and grade level of instruction allows teachers to construct professional development that caters to their niche.

School administration. An implication for school administrators is that teachers agree support is important. This parallels findings from another study, which show that elementary-level teachers' perceptions of administrative support are significant predictors of standards-based science instruction (Guskey & Sparks, 2002). Teachers need to perceive that they are receiving support from their administration; this should lead to growth in teaching instruction and thus, student achievement.

Another implication for school administrations is the connection between the negative mindset of teachers who were mandated to attend preselected sessions, as opposed to having the freedom to choose sessions at mandated trainings. Teachers can also develop this negative mindset when a school's administration does not provide differentiation based on teachers' varying experience levels (i.e. veteran teachers sitting through professional development geared toward new teachers) in professional

development. Teachers who resent being in professional development do not gain anything from the trainings because of their closed mindset.

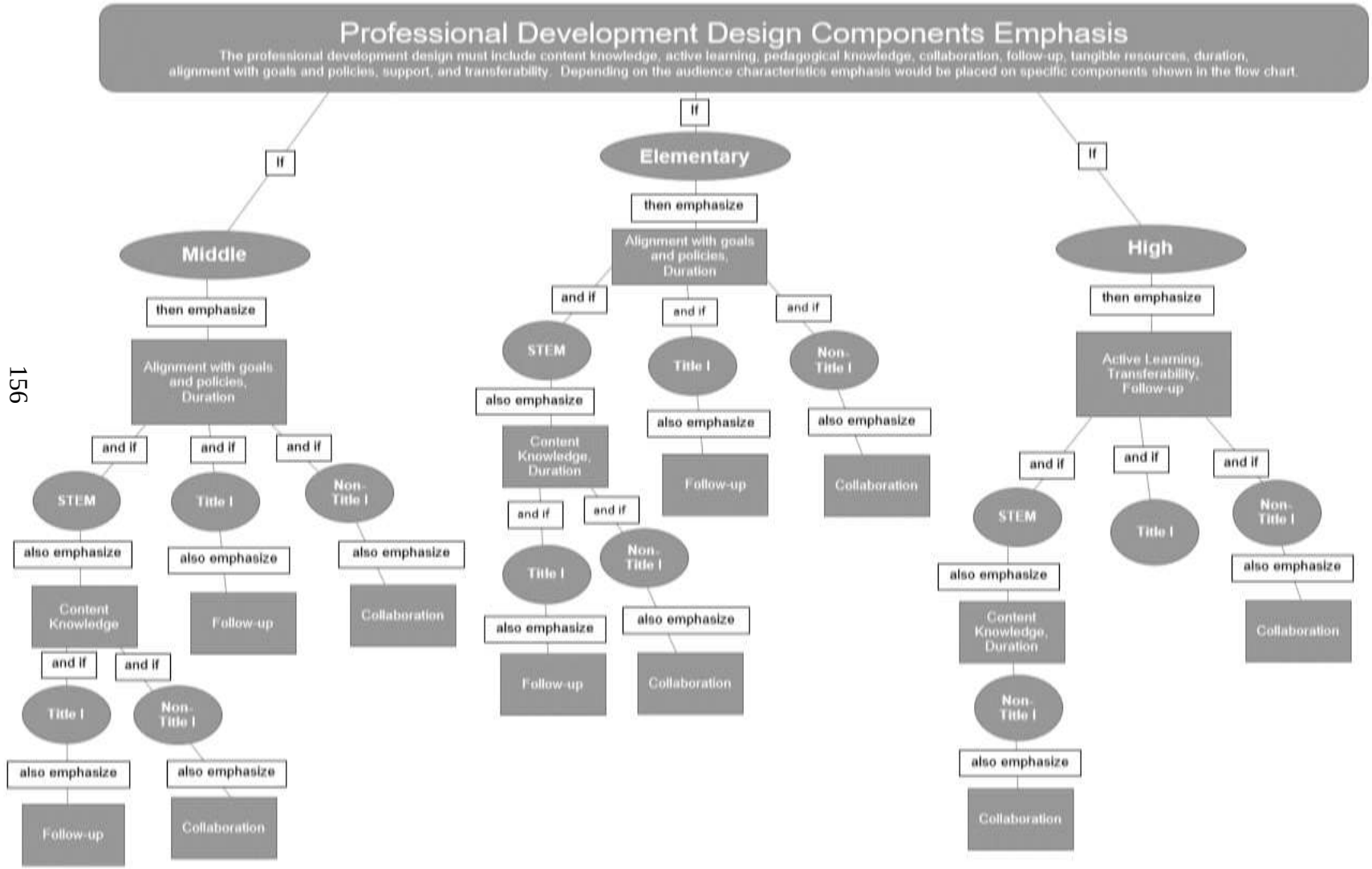

Figure 22. Professional development design component emphasis flow chart.

Teacher educators. An implication for teacher educators is how the teacher courses are structured. For example, if a professional development instructor teaches a science course to elementary teachers, he/she should provide these teachers with more opportunities to explore different teaching techniques. The rationale behind this was how frequently elementary teachers indicated agreement with survey statements about pedagogical knowledge. This finding could steer teacher educator programs.

A second implication for teacher educators is the construction of professional development trainings. Teacher educators will be able to design professional development trainings that can be altered depending on the needs of the audience. Using Figure 22, teacher educators can emphasize specific components according to the grade level of instruction, subject taught, and Title I status of the school.

Another implication for teacher educators is that more STEM teachers than non-STEM teachers agreed with the importance of including content knowledge in professional development designs. Teacher educators can work with various departments in colleges/universities to ensure that the component, content knowledge is addressed in the professional development training they construct for K-12 teachers, including STEM teachers and non-STEM teachers.

Curriculum developers. Some curriculum developers focus on topics that students learn and work on developing materials for teachers to use in the classroom while others also design professional development for teachers. The implications of this study apply to the latter type. Having a full understanding of a teacher's component preferences based on the subject he/she teaches, the Title I status of his/her school, and the grade level he/she instructs can allow curriculum developers to design trainings, tools,

and ancillary materials that he/she might find useful. Curriculum developers could use Figure 22 as a guide to help construct some of the professional development designs.

Transferability was a component that frequently came up in interviews with teachers. Likewise, this component proved to have statistical significance within the survey. One could define the component, transferability as a teacher's ability to bring information taught in professional development back to the classroom; in other words, relatability, or the sense of connectedness between professional development material and classroom teaching. Though the researcher found no statistical significance for the component, during the interviews, several participants mentioned it. On the survey, participants agreed with the importance of including the component, transferability in an effective professional development design almost equally across the grade levels. The researcher was unable to find a study that investigated professional development and relevance. The study closest to this was one that investigated the usefulness of content-specific professional development (Wei et al., 2009). The report showed that over 60 percent of elementary and secondary teachers agreed that content-focused professional development was useful. Curriculum developers must design professional development that includes transferability, considers component preferences depending on the targeted audience, and differentiates based on grade level of instruction.

Another implication for curriculum developers is the ability to create online professional development training programs, which would emphasize specific components (Figure 22) in the overall design based on the information the participant entered prior to taking the course.

Policy makers. Policy makers must face the "challenge of adopting policies that not only promote professional development for teachers but policies that encourage teachers to participate in types of professional development that have [been demonstrated to] improve teacher practices and student achievement" (Phillips, Desimone, & Smith, 2011). It would, thus, make sense for policy makers to use research that would help them to maximize these endeavors. The findings in this study show that professional development should be differentiated based on grade level of instruction. To ensure that teachers are participating in the professional development that will improve their practice, they must be engaged. Therefore, professional development trainings must feel relevant to their intended audiences.

Another implication is to provide policy-makers with a means to recycle programs created with funding that the legislation allotted, and then later terminated due to changes in monetary sources. Many programs phase out because funds run dry, or because elected officials who pushed particular programs leave office (Heck & Weiss, 2005). The federal, state, and local government departments responsible for teacher professional development would be able to alter existing programs to fit the needs of the various communities of practice found in K-12 education using the flow chart created from this study (Figure 22).

Recommendations for Future Research

The researcher has several recommendations for future research. First and foremost, conducting this study again and obtaining a larger response rate will be necessary. This study's initial findings hint at the possibility of differentiating professional development based on Title I status of the school and grade level of

instruction. To truly determine what components teachers perceive to be a part of an effective professional development design, the researcher would have to conduct a more in-depth study. The objective of this study would be to discover what teachers believe constitutes professional development. This would provide a basis for the researcher to delve into which components teachers prefer. Lastly, the researcher should conduct a study that measures the influence of years of teaching on educators' components preferences. It would be interesting to determine if there should, perhaps, be differentiation based on the length of a teacher's career.

Conclusion

To find a medium for professional development that can and will meet teachers' needs, investigators must first establish that there are several communities of practice within education. These communities use tools and knowledge to help their students. From here, creators of professional developments can design them to best suit the needs of their target audience. Some of researcher's difficulty in examining the topic of professional development was that there was an abundance of research, but -- as several researchers have pointed out -- it lacked cohesion (Buysee, Winton, & Rous, 2009; Desimone, 2009; Guskey, 2003). Some researchers tried to synthesize the research while conducting their investigations (Banilower, Heck, & Weiss, 2007; Wei et al., 2009), but this only exacerbated the confusing nature of professional development research. When trying to determine which components teachers considered part of an effective professional development design, the measurements the researcher used varied. Some measured the effectiveness of professional development via student achievement (Korelich & Maxwell, 2015; Kroeger, Blaser, Raack, Cooper, & Kinder, 2000) while

others measured the effectiveness of professional development via teacher self-efficacy (Baxter & Ruzicka, Beghetto, & Livelybrooks, 2014; Goddard, Hoy, & Woolfolk Hoy, 2004; Ross & Bruce, 2007). In addition to the disconnect and the different units of measurement for professional development, there are legislations that have added to the convoluted nature of professional development research.

Several education policies, such as No Child Left Behind, were passed during the time these researchers were investigating this subject. Likewise, research had been conducted before other policies, such as America COMPETES Reauthorization Act (which provided funding for professional development) were ratified. With the convoluted nature of professional development research and the legislation, researchers must conduct fresh investigations around professional development on a large scale. Borko (2004) described how the research on professional development should be conducted. The first phase of this research should take place at individual school sites. Phase two should occur at the school district level. The final phase should compare multiple programs taking places in multiple sites. To ensure that data collected from these studies is adequate and does not perpetuate the one-size-fits-all trend, the studies would all have to take into account the different niches, such as grade level of instruction and Title I status of the school, found in education. Conducting research in these phases should provide a more solid foundation to cultivate professional development on, thus minimizing the disconnect and dissatisfaction teachers have expressed.

In this study, teachers communicated a need for differentiation based on grade level of instruction, Tittle I status of the school, and subject taught, both in interviews and with high percentages of agreement in the final questions of the survey. However,

statistical analysis indicated that there was no significant statistical difference for Title I status of the school and subject taught. Grade level of instruction did show statistically significant effects on the total score of component importance in an effective professional development design, indicating that professional development should be differentiated based on elementary and secondary instruction.

When the researcher reviewed the components, some showed that the independent variables, Title I status of the school and grade level of instruction had a statistically significant effect. Although the ordinal logistic regression revealed a lack of statistical significance, percent differences calculated by the frequency divided by the total in each group indicated that factors such as subject taught, Title I status of the school, and grade level of instruction influenced teachers' preferences regarding specific components in an effective professional development design. These findings illustrate promise that in a larger study, statistical significance might occur, showing that professional development should be differentiated based on subject taught, Title I status of the school, and grade level of instruction. If "best teaching practices are those that consider all learners in a classroom setting and pay close attention to differences inherent to academic, cultural, linguistic, and socioeconomic diversity" (Santamaria, 2009, p. 241), then why is professional development not designed this way?

APPENDICES

Appendix A

Email Requesting Interview.

Subject Line: Interview for a Doctoral Study

Hi <Participant Name>,

I am a doctoral student at Florida Atlantic University, and currently working on my dissertation research. I am inquiring about teachers' perceptions of the components necessary to create a professional development design that is effective. It is for this purpose that I would like to request an interview with you, at a place and time of your choice. If a face-to-face interview is not possible I can meet via web chat or over the phone.

These interviews will be used as part of a larger study; how factors such as grade level of instruction (elementary, middle, and high), subject matter taught (STEM and non-STEM), and Title I status of the school (Title I and non-Title I) influence the components included in the professional development design.

The participants' identities will be kept in strict confidence, and pseudonyms will be used to maintain confidentiality of all participants in this study always.

I will gladly respond to any questions or concerns you may have about participating in the study, and I look forward to hearing from you at your convenience.

Sincerely,

Kristen Perez, MHA

[redacted]

Appendix B

Interview Consent Form.

Adult Consent Form

1) Title of Research Study: Influences of STEM, Title I, and grade level of instruction on Teachers' Preferences of Effective Professional Development Design Components

2) Investigator(s): David Kumar and Kristen Perez

3) Purpose: The purpose of this study is to explore the perceptions that teachers have regarding components that should be included in an effective professional development design. Also, if factors such as subject matter taught (STEM and nonSTEM), Title I status (Title I and nonTitle I) of the school, and grade level of instruction (elementary, middle, and high) influence teachers' preferences of which components should be included.

4) Procedures: Participation in this study involves one 25-30 minutes semi-structured interview that will be recorded; with a potential follow up interview should this be deemed necessary. Participants may deny access to this documentation and may withdraw from the study at any time. The participants' identities will be kept in strict confidence and pseudonyms will be used to maintain confidentiality of all participants in this study.

5) Risks: The risks involved with participation in this study are no more than you would experience in regular daily activities. It is unlikely you will experience any harm or discomfort. Participants can withdraw from the study at any point without prejudice or penalty.

6) Benefits: Potential benefits to the participant include a greater understanding of the components that teachers perceive as necessary for an effective professional development design. In addition, increasing the depth of knowledge of the definition of effective professional development designs as defined by its targeted audience.

7) Data Collection & Storage: With your authorization, this interview will be recorded and transcribed. All of the results will be kept confidential and secure and only the investigator working with the study will see your data, unless required by law. The data will be kept for 5 years or until researcher degree completion. After that time, paper copies will be destroyed by shredding and electronic data will be deleted.

8) Contact Information: For other questions about the study, you should call the principal investigator: Dr. David Kumar at [redacted] r Kristen Perez at [redacted]

9) Consent Statement (1) I have read or had read to me the preceding information describing this study. All my questions have been answered to my satisfaction. I am 18 years of age or older and freely consent to participate. I understand that I am free to withdraw from the study at any time without penalty.

I agree ____ I do not agree ___ to be audiotaped

Signature of Subject:_____ Date: _____

Printed First Name _____ Last Name_____

Signature of Investigator: _____ Date: _____

FAU Institutional Review Board

1016338-2	
Approved On:	March 9, 2017
Expires On:	March 9, 2018

Appendix C

Email Requesting Survey Participation.

Subject Line: Survey for a Doctoral Research Study

Hi Fellow Educator,

I am a doctoral candidate at Florida Atlantic University writing to invite you to participate in a research study investigating if teachers' preference for components in an effective professional development design is influenced by grade level of instruction (elementary, middle, and high), Title I status of the school, and subject matter taught.

The participants' identities will be kept in strict confidence and the survey should take no more than 20 minutes of your time.

Follow this link to the Survey:

${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:

${l://SurveyURL}

Follow the link to opt out of future emails:

${l://OptOutLink?d=Click here to unsubscribe}

I will gladly respond to any questions or concerns you may have about participating in the study.

Thank you,

Kristen Perez, MHA

[redacted]

Appendix D

Interview Protocol.

Opening:

Thank you for participating in this interview. The interview is intended to further an understanding of what components teachers perceive as necessary to create an effective professional development design. I am a FAU doctoral student currently working on collecting data for my dissertation. This study is intended to be included in the final paper and may be published. Your identity will be kept in strict confidence with the use of pseudonyms.

May I have your permission to record the interview? Also, with your permission, I will transcribe the interview and email you the transcript for you to review your responses and make any corrections, if necessary. Would that be okay?

Interview Questions:

Background:

1. How long have you been teaching? Have these all been with the [redacted]?
2. Are you currently teaching at a Title I school?
3. What STEM subjects have you taught over the course of your teaching career?
4. Is there a subject out of these that you prefer to teach? Why?

Professional Development Perceptions:

1. When offered the opportunity how often would you say you attend professional development sessions? Where any of these specifically for your subject matter?
2. Tell me about some of the professional developments programs that you attended in the past year? (Probe: These could have been offered by the district or your school?)
    a. Was this PD related to your subject matter?
3. Please describe some of the things that you did during one that was particularly meaningful of the professional development programs you mentioned.
4. Did you feel that there was something missing or lacking in the professional development you attended? If so, what was it you felt was missing or lacking?
5. Tell me about what has been transferable to your classroom?
6. Do you still implement them today? Have you modified them from what was originally shown in the PD? If so how?
7. If PD was being offered at your school or district what should be included in the professional development design to meet your needs as a teacher? (Probe: If you were asked to design/ create a lesson for professional development for your subject matter what would it look like?

8. Literature on professional development has expressed that there are specific components that should be included in a professional development design. Nine of these have been chosen for this study they are

a. Content Knowledge
b. Practice/ Active Learning
c. Pedagogical content (i.e. carousel, popcorn, jigsaw)
d. Length of time
e. Collaboration with peers
f. Reflection
g. Support (i.e. coaches, PLC)
h. Alignment with goals and/or policies
i. Resources

If you were asked to identify from these which are more or most important to be included in a professional development design, which would you include or exclude?

Closing:

Thank you again for taking the time to answer these questions. Just a reminder that all information shared during this interview will be confidential.

Appendix E

Survey Protocol.

PD Survey for K. Perez Dissertation

Agreement- Consent Statement

Q1 Thank you for your interest in participating in our research study. The purpose of the study is to discover if factors such as grade level of instruction (elementary, middle, and high), Title I status (Title I and nonTitle I) of the school, and subject matter taught (STEM and nonSTEM) influence what components teachers perceive as necessary to create an effective professional development design.

It should take you no more than 20 minutes to complete this survey. Your participation in this study is your choice. You are free to withdraw from the study at any time without penalty. The risks involved with participating in this study are no more than you would experience in regular daily activities. Your identity will be kept in strict confidence and the survey does not include any identifying markers that will link a participant to his or her responses.

Potential benefits that you may receive from participation include a greater understanding of the components that teachers perceive as necessary for an effective professional development design. In addition, increasing the depth of knowledge of the definition of effective professional development designs as defined by its targeted audience.

If you experience problems or have questions regarding your rights as a research subject, contact the F[redacted] For other questions about the study, you should call the principal investigator: Dr. David Kumar at [redacted] or Kristen Perez at [redacted]. By completing the survey, you give consent to participate in this study. If you choose, you can print a copy of the consent statement for personal records.

O Agree (1)

O Disagree (2)

Skip To: End of Survey If Q1 = Disagree (2)

Q2 How many years have you been an educator?

Q4 Do you teach at a Title I school?

O Yes (1)

O No (2)

Q5 Have you been employed with the [redacted] for at least one full school year?

- Yes (1)
- No (2)

Q6 Do you teach a science, technology, engineering, and/or mathematics course?

- Yes (1)
- No (2)

Skip To: Q3 If Q6 = No (2)

Q7 Please select all the course(s) you taught in past three years.

- [ ] Science (1)
- [ ] Technology (2)
- [ ] Engineering (3)
- [ ] Mathematics (4)

Q3 What grade level do you teach?

- Elementary (K-5) (1)
- Middle (6-8) (2)
- High (9-12) (3)

Skip To: Q8 If Q3 = Elementary (K-5) (1)
Skip To: Q11 If Q3 = Middle (6-8) (2)
Skip To: Q11 If Q3 = High (9-12) (3)

Q8 As an elementary teacher that teaches all subject areas, which area do you feel that you have the strongest content knowledge in?

- O Language Arts/ English (1)
- O Mathematics (2)
- O Science (3)
- O Social Studies (4)

Q9

Q10

Q11 Please select all the location(s) for the professional development you have been a participant of in the past three years.

- ☐ School Site (1)
- ☐ District (2)
- ☐ Location in county other than the District (4)
- ☐ Out of the county but in State (5)
- ☐ In another State (6)

Q12 In the professional development offered by the school or the district that you have participated in the past year, please select each of the components that you have "seen" or are aware of that were part of the professional development training.

- [ ] Content Knowledge- the topic or matter dealt with in a field of study (i.e. science, reading). (1)
- [ ] Pedagogical Knowledge- pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning. (2)
- [ ] Active Learning- modeling new strategies and practice (3)
- [ ] Support- interaction with professionals in the field; emotional; administrative. (4)
- [ ] Collaboration- methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email. (5)
- [ ] Resources- tangible: “take-aways” i.e. worksheets, website links, workbook, lab equipment. Intangible: relate-ability to classroom; able to bring back to the classroom and use (6)
- [ ] Aligned with Goals and Policies- being part of a school or district based reform effort. (7)
- [ ] Follow-up- a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring. (8)
- [ ] Duration- received at least 14 hours (spread out of several trainings) of meaningful professional development training. (9)

Q13 How many hours would you say you have participated in professional development training(s) this past school year? (These could be provided in school, at the district, during LTM/PDD days)

_____

End of Block

Components of a Professional Development Design

Q14 How frequently should a teacher participate in professional development?

O Daily (1)

O Weekly (2)

O Biweekly (3)

O Monthly (4)

O Annually (5)

O Biannually (6)

Q15 How many hours should an "effective" professional development training last?

O 1-2 (1)

O 3-4 (2)

O 5-6 (3)

O 7-8 (4)

Q16 Please rank your preference for the inclusion of the following components in a professional development design. Drag and drop each component: 1 being most preferred, 10 being least preferred.

_____ Content knowledge- (topics or matter dealt with in a field of study i.e. science, reading). (1)

_____ Pedagogical knowledge- (pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning). (2)

_____ Active learning- (modeling new strategies and practice). (3)

_____ Support- (interaction with professionals in the field). (4)
_____ Emotional support- (expressed through commiserating with and encouragement from other educators and administrators). (5)
_____ Collaboration- (methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email). (6)
_____ Tangible resources- ("take-aways" i.e. worksheets, website links, workbook, lab equipment). (7)
_____ Intangible resource- (relate-ability to the classroom; able to bring back to the classroom and use). (8)
_____ Aligned with goals and policies- (being part of a school or district based reform effort). (9)
_____ Follow-up- (a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring). (10)

Q17 For me **content knowledge** (topics or matter dealt with in a field of study i.e. science, reading) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q18 For me pedagogical knowledge (pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q19 For me active learning (modeling new strategies and practice) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q20 For me support (interaction with professionals in the field) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q21 For me emotional support (expressed through commiserating with and encouragement from other educators and administrators) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q22 For me collaboration (methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q23 For me tangible resources ("take-aways" i.e. worksheets, website links, workbook, lab equipment) is an important aspect of a professional development design.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q24 For me intangible resource (relate-ability to the classroom; able to bring back to the classroom and use) is an important aspect of a professional development design.

- O Strongly disagree (2)
- O Somewhat disagree (6)
- O Neither agree nor disagree (7)
- O Somewhat agree (8)
- O Strongly agree (9)

Q25 For me aligned with goals and policies (being part of a school or district based reform effort) is an important aspect of a professional development design.

- O Strongly disagree (2)
- O Somewhat disagree (6)
- O Neither agree nor disagree (7)
- O Somewhat agree (8)
- O Strongly agree (9)

Q26 For me follow-up (a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring) is an important aspect of a professional development design.

- O Strongly disagree (2)
- O Somewhat disagree (6)
- O Neither agree nor disagree (7)
- O Somewhat agree (8)
- O Strongly agree (9)

Q27 For me duration (received at least 14 hours (spread out over several trainings) of meaningful professional development) is an important aspect of a professional development design.

- O Strongly disagree (2)
- O Somewhat disagree (6)
- O Neither agree nor disagree (7)
- O Somewhat agree (8)
- O Strongly agree (9)

Q28 The needs of a Title I school in regards to professional development training should be different than those at a non-Title I school.

- O Strongly disagree (2)
- O Somewhat disagree (6)
- O Neither agree nor disagree (7)
- O Somewhat agree (8)
- O Strongly agree (9)

Q29 The structure of a professional development training should look different depending on the subject matter taught (STEM and nonSTEM).

- O Strongly disagree (2)
- O Somewhat disagree (6)
- O Neither agree nor disagree (7)
- O Somewhat agree (8)

O Strongly agree (9)

Q30 Professional development training should include material that specifically addresses the needs of Title I schools.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

Q31 Professional development training should include material that specifically addresses the needs of grade level of instruction.

O Strongly disagree (2)

O Somewhat disagree (6)

O Neither agree nor disagree (7)

O Somewhat agree (8)

O Strongly agree (9)

End of Block

Conclusion

Q33 Are there any other components that have not been mentioned in this survey that you feel should be included in a professional development design?

Q9 Sex (based on the biological attributes of men and women (chromosomes, anatomy, hormones) -U.S. Census Bureau

- Male (1)
- Female (2)

Q52 Ethnicity & Race
Mark all boxes that apply

- White (1)
- Black or African American (2)
- American Indian or Alaska Native (3)
- Asian (4)
- Native Hawaiian or Pacific Islander (5)
- Hispanic or Latino (7)
- Some other race or ethnicity (6)

Q53 Age

_____

End of Block

Appendix F

Second Email Requesting Survey Participation.

Subject Line: Survey for a Doctoral Study

Thank you so much for taking the time to begin the survey. I know that this time of year we are all very busy and asking for a few minutes to complete the survey is a lot but it would be greatly appreciated.

Thank you again and Happy Thanksgiving!

Follow this link to the Survey:

${l://SurveyLink?d=Take the Survey}

Or copy and paste the URL below into your internet browser:

${l://SurveyURL}

Follow the link to opt out of future emails:

${l://OptOutLink?d=Click here to unsubscribe}

The research study is investigating if teachers' preference for components in an effective professional development design is influenced by grade level of instruction (elementary, middle, and high), Title I status of the school, and subject matter taught.

The participants' identities will be kept in strict confidence and the survey should take no more than 20 minutes of your time.

I will gladly respond to any questions or concerns you may have about participating in the study.

Kristen Perez, MHA

Appendix G

Pilot Study Protocol.

IRB Submission Survey Template

Q1 Thank you for your interest in participating in our research study. The purpose of the study is to discover if factors such as grade level of instruction (elementary, middle, and high), Title I status (Title I and nonTitle I) of the school, and subject matter taught (STEM and nonSTEM) influence what components teachers perceive as necessary to create an effective professional development design. It should take you no more than 20 minutes to complete this survey. Your participation in this study is your choice. You are free to withdraw from the study at any time without penalty. The risks involved with participating in this study are no more than you would experience in regular daily activities. Your identity will be kept in strict confidence and the survey does not include any identifying markers that will link a participant to his or her responses. Potential benefits that you may receive from participation include a greater understanding of the components that teachers perceive as necessary for an effective professional development design. In addition, increasing the depth of knowledge of the definition of effective professional development designs as defined by its targeted audience. If you experience problems or have questions regarding your rights as a research subject, contact the [redacted] For other questions about the study, you should call the principal investigator: Dr. David Kumar at [redacted] or Kristen Perez at [redacted]. By completing the survey, you give consent to participate in this study. If you choose, you can print a copy of the consent statement for personal records.

- ❍ Agree (1)
- ❍ Disagree (2)

Q2 How many years have you been an educator?

Q3 What grade level do you teach?

- ❍ Elementary (K-5) (1)
- ❍ Middle (6-8) (2)
- ❍ High (9-12) (3)

Q4 Do you teach at a Title I school?

- ❍ Yes (1)
- ❍ No (2)

Q5 Have you been employed with the [redacted] for at least one full school year?

- ❍ Yes (1)
- ❍ No (2)

Q6 Do you teach a science, technology, engineering, and/or mathematics course?

- ❍ Yes (1)
- ❍ No (2)

Q7 If you responded yes to the above question please select all the course(s) you teach.

- ❑ Science (1)
- ❑ Technology (2)
- ❑ Engineering (3)
- ❑ Mathematics (4)

Q8 Elementary Teacher Only need to respond to this question. If you are an elementary teacher that teaches all subject areas, which area do you feel that you have the strongest content knowledge in?

- ❍ Language Arts/ English (1)
- ❍ Mathematics (2)
- ❍ Science (3)
- ❍ Social Studies (4)

Q9 Gender

- ❍ Male (1)
- ❍ Female (2)

Q10 Have you participated in a school or district created professional development training(s) in the past year?

- ❍ Yes (1)
- ❍ No (2)

Q11 If you answered "yes" to the previous question, where was the training(s) located?

- ❍ School Site Only (1)
- ❍ District Only (2)
- ❍ School Site and District (3)
- ❍ Neither at the school site nor the district (4)

Q12 In the professional development offered by the school or the district that you have participated in the past year, please select each of the components that you have "seen" or are aware of that were part of the professional development training.

- ❑ Content Knowledge- the topic or matter dealt with in a field of study (i.e. science, reading). (1)
- ❑ Pedagogical Knowledge- pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning. (2)
- ❑ Active Learning- modeling new strategies and practice (3)
- ❑ Support- interaction with professionals in the field; emotional; administrative. (4)
- ❑ Collaboration- methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email. (5)
- ❑ Resources- tangible: "take-aways" i.e. worksheets, website links, workbook, lab equipment. Intangible: relate-ability to classroom; able to bring back to the classroom and use (6)
- ❑ Aligned with Goals and Policies- being part of a school or district based reform effort. (7)
- ❑ Follow-up- a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring. (8)
- ❑ Duration- received at least 14 hours (spread out of several trainings) of meaningful professional development training. (9)

Q13 How many hours would you say you have participated in professional development training(s) this past school year? (These could be provided in school, at the district, during LTM/PDD days)

Q14 How frequently should a teacher participate in professional development?

- ❍ Daily (1)
- ❍ Weekly (2)
- ❍ Biweekly (3)
- ❍ Monthly (4)

Q15 How many hours should an "effective" professional development training last?

- ❍ 1-2 (1)
- ❍ 3-4 (2)
- ❍ 5-6 (3)
- ❍ 7-8 (4)

Q16 Please indicate your preference for the inclusion of the following components in a professional development design.

	Prefer a great deal (1)	Prefer a lot (2)	Prefer a moderate amount (3)	Prefer slightly (4)	Do not prefer (5)
1. Content knowledge (topics or matter dealt with in a field of study i.e. science, reading). (1)	❍	❍	❍	❍	❍
2. Pedagogical knowledge (pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning). (2)	❍	❍	❍	❍	❍
3. Active learning (modeling new strategies and practice). (3)	❍	❍	❍	❍	❍
4. Support (interaction with professionals in the field). (4)	❍	❍	❍	❍	❍
5. Emotional support (expressed through commiserating with and encouragement from other educators and administrators). (5)	❍	❍	❍	❍	❍

6. Collaboration (methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email). (6)	❍	❍	❍	❍	❍
7. Tangible resources ("take-aways" i.e. worksheets, website links, workbook, lab equipment). (7)	❍	❍	❍	❍	❍
8. Intangible resource relate-ability to the classroom (able to bring back to the classroom and use). (8)	❍	❍	❍	❍	❍
9. Aligned with goals and policies (being part of a school or district based reform effort). (9)	❍	❍	❍	❍	❍

10. Follow-up (a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring). (10)	❍	❍	❍	❍	❍

Q17 Professional development should include content knowledge (topics or matter dealt with in a field of study i.e. science, reading).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q18 Professional development should include pedagogical knowledge (pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q19 Professional development should include active learning (modeling new strategies and practice).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q20 Professional development should include support (interaction with professionals in the field).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q21 Professional development should include emotional support (expressed through commiserating with and encouragement from other educators and administrators).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q22 Professional development should include collaboration (methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q23 Professional development should include tangible resources ("take-aways" i.e. worksheets, website links, workbook, lab equipment).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q24 Professional development should include intangible resource (relate-ability to the classroom; able to bring back to the classroom and use).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q25 Professional development should be aligned with goals and policies (being part of a school or district based reform effort).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q26 Professional development should include follow-up (a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q27 Professional development should include duration (received at least 14 hours (spread out of several trainings) of meaningful professional development).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q28 The needs of a Title I school in regards to professional development training should be different than those at a non-Title I school.
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q29 The structure of a professional development training should look different depending on the subject matter taught (STEM and nonSTEM).
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q30 Professional development training should include material that specifically addresses the needs of Title I schools.
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q31 Professional development training should include material that specifically addresses the needs of grade level of instruction.
(1) Strongly Disagree (2) Somewhat Disagree (3) Neither Agree nor Disagree (4) Somewhat Agree (5) Strongly Agree

Q32 If you were asked to design a professional development which components would you include. Please drag each component into the design box.

Part of my professional development
_____ Content knowledge (topics or matter dealt with in a field of study i.e. science, reading). (1)
_____ Pedagogical knowledge (pedagogical methods taught during PD i.e. scaffolding, differentiated instruction, problem based learning). (2)
_____ Active learning (modeling new strategies and practice). (3)
_____ Support (interaction with professionals in the field). (4)
_____ Support (interaction with professionals in the field). (5)
_____ Emotional support (expressed through commiserating with and encouragement from other educators and administrators). (6)
_____ Collaboration (methods that help reshape views and beliefs of content and pedagogical knowledge i.e. PLCs, common planning, blogging, message boards, and email). (7)
_____ Tangible resources ("take-aways" i.e. worksheets, website links, workbook, lab equipment). (8)
_____ Intangible resource relate-ability to the classroom (able to bring back to the classroom and use). (9)
_____ Aligned with goals and policies (being part of a school or district based reform effort). (10)
_____ Follow-up (a person or a group of people that the participant can reach out to (by email or telephone) and/or continues to interact with in the form of coaching or mentoring) (11)

Q33 Are there any other components that have not been mentioned in this survey that you feel should be included in a professional development design?

Appendix H

Cross Reference Matrix of Survey and Interview Questions.

Table H1

Cross reference of research questions, variables, and interview and survey questions

Research Question	Research Variable	Relevant survey item	Relevant interview protocol item[a]
What are K-12 school teachers' perceptions of effective professional development design in a large public-school district located in the southeastern part of the United States?	–	–	3,4,8
Does subject taught (STEM and non-STEM) influence preferences regarding components that should be included in an effective professional development design?	IV1	6, 7, 8, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29	–
What are the differences, regarding preferences for components that should be included in an effective professional development design, between the teachers at Title I schools and teachers at non-Title I schools?	IV2	4, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 30	–
What are primary and secondary teachers' preferences regarding which components are part of effective professional development design?	IV3	3, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 31	–
Are the differences in the components of the professional development design between STEM and non-STEM teachers a function of the Title I status of the school (Title I and non-Title I)?	IV1, IV3		–

[a]Questions indicated on the table are from the Professional Development Perceptions section of the interview protocol.

Appendix I

Coding Process for Interviews.

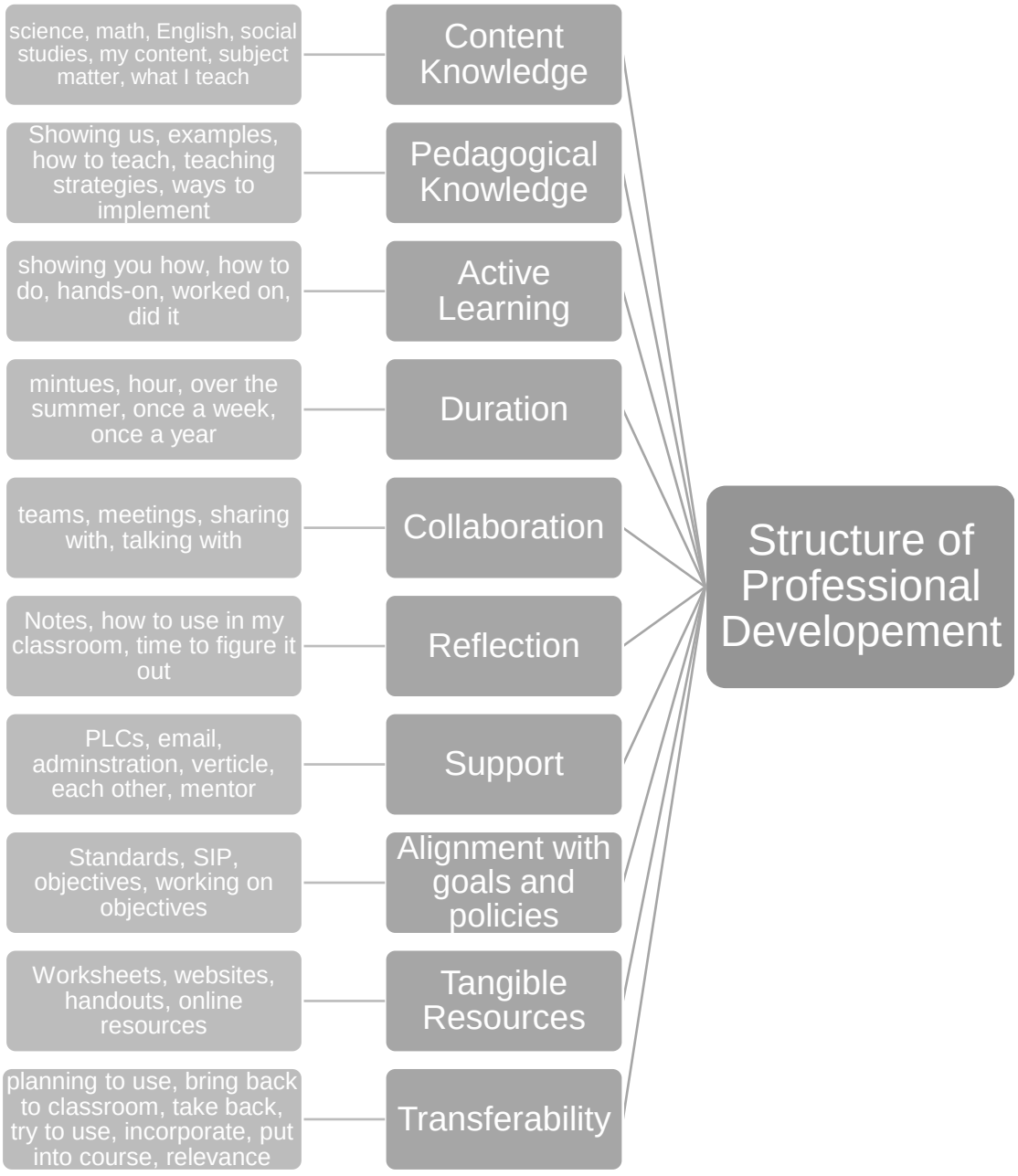

Figure I1. A priori for components in an effective professional development design coding process.

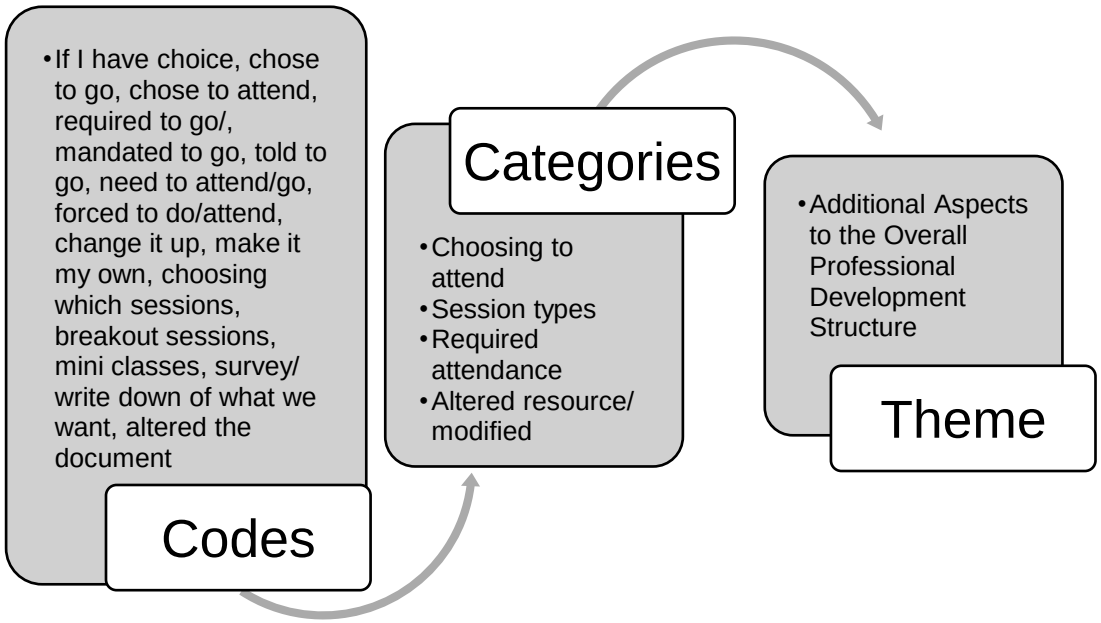

Figure I2. Structure of professional development theme coding process.

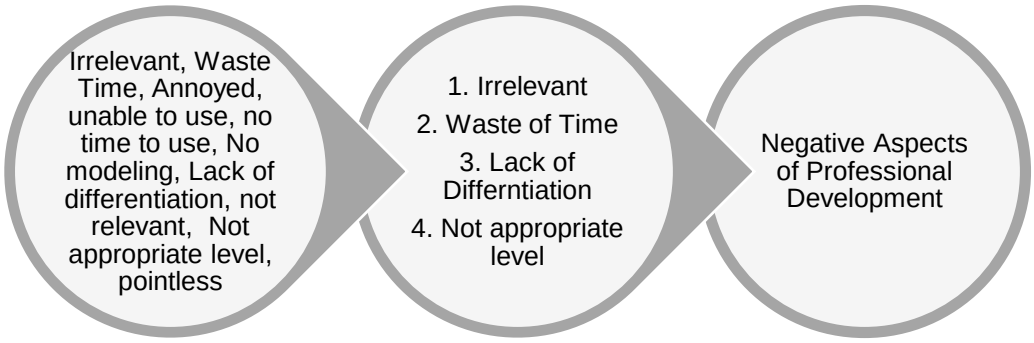

Figure I3. Negative aspects of professional development theme coding process.

Appendix J

Assumptions Data for the Ordinal Logistic Regression.

Table J1

Collinearity statistics for ordinal logistic regression

	STEM		Middle		Elementary		Title I	
Component	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF	Tolerance	VIF
Content Knowledge	.930	1.075	.769	1.301	.698	1.432	.956	1.046
Pedagogical Knowledge	.928	1.078	.767	1.303	.694	1.440	.954	1.048
Active Learning	.930	1.075	.768	1.301	.698	1.432	.956	1.046
Collaboration	.926	1.080	.767	1.304	.694	1.442	.955	1.048
Support	.931	1.075	.767	1.304	.698	1.434	.956	1.046
Emotional Support	.932	1.073	.769	1.301	.699	1.430	.954	1.048
Alignment with goals and policies	.930	1.076	.766	1.306	.694	1.441	.953	1.049
Tangible Resources	.931	1.074	.769	1.301	.699	1.430	.957	1.045
Transferability	.931	1.074	.768	1.302	.699	1.432	.955	1.048
Follow-up	.930	1.075	.769	1.301	.700	1.429	.957	1.045
Duration	.929	1.077	.768	1.302	.698	1.433	.956	1.046

Table J2

Test of Parallel Lines

Components	-2 Log Likelihood		Chi-Square[a]	Sig.*
	Null Hypothesis	General		
Content Knowledge	194.647	139.797	54.850	.000*
Pedagogical Knowledge	200.035	183.257	16.778	.158
Active Learning	159.121	148.719	10.402	.581
Collaboration	184.525	173.647	10.878	.539
Support	182.984	172.240	10.743	.551
Emotional Support	200.459	189.853	10.606	.563
Alignment with goals and policies	203.726	192.650	11.076	.522
Tangible Resources	170.369	155.571	14.798	.253
Transferability	182.559	175.107	7.452	.826
Follow-up	206.888	182.370	24.518	.017*
Duration	204.550	194.375	10.174	.601

*$p > .05$

[a]4 degrees of freedom

Table J3

Variables in the Equation for Proportional Odds Assumption for Content Knowledge

	B				Exp(B)			
Step 1[a]	Cat1	Cat2	Cat3	Cat4	Cat1	Cat2	Cat3	Cat4
Teach Title I Yes vs. No	.683	.182	-.180	-.009	1.980	1.200	.836	.991
Teach STEM Yes vs. No	-.426	-.283	-.367	-.246	.653	.753	.693	.782
Grade Level Taught	–	–	–	–	–	–	–	–
Grade Level Taught Elementary vs. High	.308	-.214	-.047	-.280	1.361	.808	.954	.755
Grade Level Taught Middle vs. High	-.243	-.438	-.081	-.116	.784	.645	.922	.890
Constant	-2.983	-1.851	-1.395	-.212	.051	.157	.248	.809

Note. Cat1 ≤ Strongly disagree, Cat2 ≤ Disagree, Cat3 ≤ Neutral, Cat4 ≤ Agree

[a]Variable(s) entered on step 1: TeachTitleI, TeachSTEM, GradeLevelTaught.

Table J4

Variables in the Equation for Proportional Odds Assumption for Follow-up

	B				Exp(B)			
Step 1[a]	Cat1	Cat2	Cat3	Cat4	Cat1	Cat2	Cat3	Cat4
Teach Title I Yes vs. No	-.396	-.584	-.277	.026	.673	.558	.758	1.027
Teach STEM Yes vs. No	-.396	-.184	-.045	.353	.673	.832	.956	1.423
Grade Level Taught	–	–	–	–	–	–	–	–
Grade Level Taught Elementary vs. High	.782	.165	-.435	-.266	2.186	1.180	.647	.767
Grade Level Taught Middle vs. High	1.048	.366	.249	-.077	2.851	1.443	1.282	.926
Constant	-3.278	-1.615	-.134	1.176	.038	.199	.875	3.242

Note. Cat1 ≤ Strongly disagree, Cat2 ≤ Disagree, Cat3 ≤ Neutral, Cat4 ≤ Agree

[a]Variable(s) entered on step 1: TeachTitleI, TeachSTEM, GradeLevelTaught.

Table J5

Ordinal Logistic Regression Goodness-of-fit Output

	Pearson		Deviance	
Component	Chi-Square[a]	Sig.*	Chi-Square[a]	Sig.*
Content Knowledge	56.669	.042*	60.647	.019*
Pedagogical Knowledge	66.434	.005*	67.863	.004*
Active Learning	34.854	.701	37.908	.565
Collaboration	30.652	.856	31.246	.838
Support	33.332	.763	37.491	.584
Emotional Support	34.157	.730	35.651	.666
Alignment with goals and policies	46.784	.214	49.298	.149
Tangible Resources	35.382	.678	36.616	.623
Transferability	38.077	.557	45.900	.241
Follow-up	46.462	.223	46.632	.218
Duration	40.714	.439	39.913	.474

* $p > .05$

[a]40 degrees of freedom

Table J6

Ordinal Logistic Regression Model Fitting Information

Components	-2 Log Likelihood		Chi-Square[a]	Sig.*
	Intercept Only	Final		
Content Knowledge	200.236	194.647	5.589	.232
Pedagogical Knowledge	213.031	200.035	12.996	.011*
Active Learning	171.845	159.121	12.723	.013*
Collaboration	196.354	184.525	11.830	.019*
Support	187.902	182.984	4.919	.296
Emotional Support	204.238	200.459	3.779	.437
Alignment with goals and policies	224.130	203.726	20.404	.000*
Tangible Resources	176.302	170.369	5.933	.204
Transferability	189.350	182.559	6.791	.147
Follow-up	215.039	206.888	8.151	.086
Duration	210.188	204.550	5.639	.228

*$p > .05$

[a]4 degrees of freedom

Appendix K

Three-way Repeated Measure ANOVA Data.

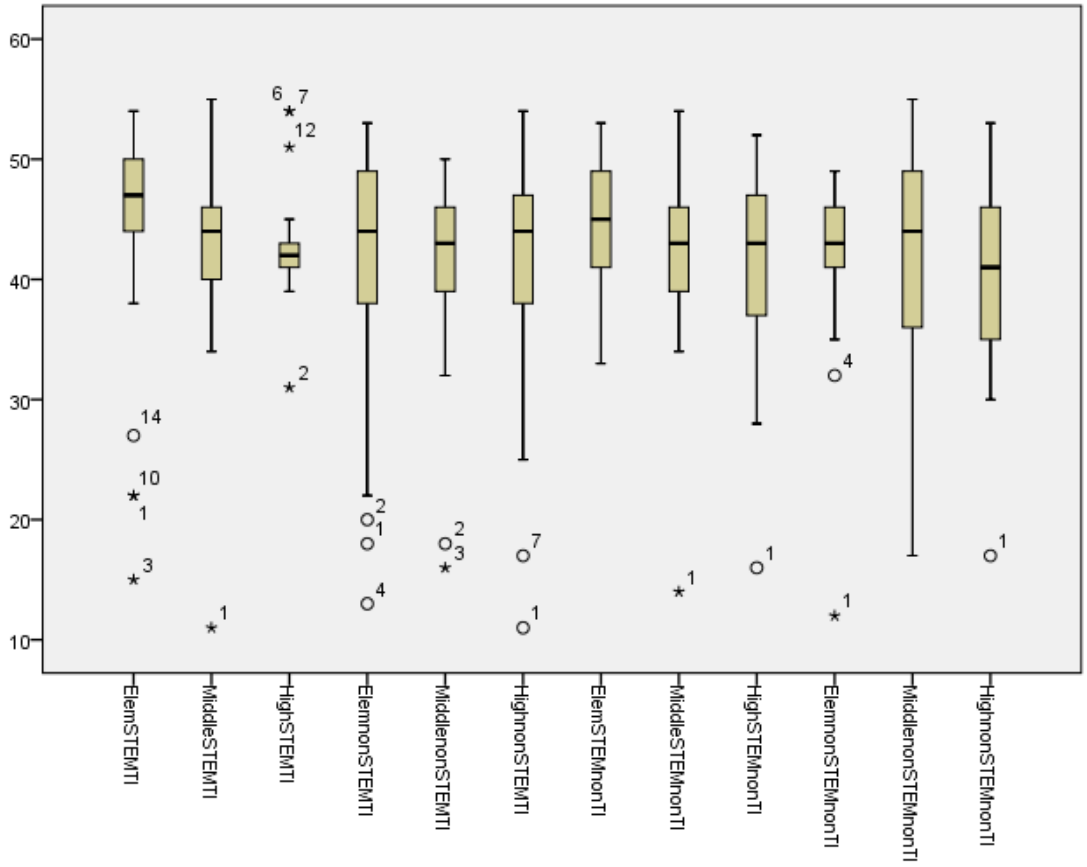

Figure K1. Box plot outliers for the three-way repeated measures ANOVA.

Table K1

Shapiro-Wilk's test of normality of the Three-Way Repeated Measures ANOVA

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Elementary-STEM-Title I	.286	25	.000	.772	25	.000
Middle-STEM-Title I	.226	25	.002	.806	25	.000
High-STEM-TitleI	.273	25	.000	.848	25	.002
Elementary-non-STEM-Title I	.284	25	.000	.807	25	.000
Middle-non-STEM-Title I	.233	25	.001	.780	25	.000
High-non-STEM-Title I	.254	25	.000	.834	25	.001
Elementary-STEM-non-Title I	.138	25	.200*	.960	25	.415
Middle-STEM-non-Title I	.149	25	.159	.825	25	.001
High-STEM-non-Title I	.153	25	.133	.912	25	.034
Elementary-non-STEM-non-Title I	.281	25	.000	.706	25	.000
Middle-non-STEM-non-Title I	.105	25	.200*	.922	25	.056
High-non-STEM-non-Title I	.178	25	.040	.936	25	.122

* This is a lower bound of the true significance.

[a] Lilliefors Significance Correction

Table K2

Mauchly's Test of Sphericity of the three-way repeated measures ANOVA

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.*	Epsilon		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Teach TitleI	1.000	.000	0	−	1.000	1.000	1.000
Teach STEM	1.000	.000	0	−	1.000	1.000	1.000
Grade Level	.972	.648	2	.723	.973	1.000	.500
TeachTitleI x TeachSTEM	1.000	.000	0	−	1.000	1.000	1.000
TeachTitleI x GradeLevel	.568	13.024	2	.001*	.698	.728	.500
TeachSTEM x GradeLevel	.895	2.557	2	.278	.905	.974	.500
TeachTitleI x TeachSTEM x GradeLevel	.743	6.822	2	.033*	.796	.843	.500

* $p < .05$

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