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STEM Professional Development and Integration in Elementary Schools

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STEM PROFFESIONAL DEVELOPMENT

AND INTEGRATION IN ELEMENTARY SCHOOLS

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SIGNATURE PAGE

Diana V. Cantu prepared this research study under the direction of Dr. John M. Ritz in SEPS 636, Problems in Occupational and Technical Studies. It was submitted to the Graduate Program Director as partial fulfillment for the requirements for the degree of Master of Science in Occupational and Technical Studies.

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CHAPTER I

INTRODUCTION

The United States is currently experiencing a shortage of professional engineers and technologists. This coincides with the growing trend of American students falling behind in the areas of science, technology, engineering, and mathematics education, also known as STEM education. The National Science Board (2010) recognized the shortage and realized the immediate need for teachers in the area of STEM subject matters. In 2008, AeA, the nation's largest technology trade association representing all segments of the high-tech industry at the time, released a press statement where Matthew Kazmierczak, Vice President of Research and Industry Analysis, stated:

> Our tech industry is thriving. In order to maintain this growth we need to make sure that the lifeblood of our industry, our highly skilled and highly educated workers, is available. Right now the United States isn't doing enough to educate the next generation of programmers, scientists, and engineers. (AeA, 2008, para. 5)

K-12 institutions are not integrating STEM education into their curriculum to meet this deficit (NSB, 2010). As societies continue their dependence on technology, the need for integrating STEM curricula at all levels is imperative to succeed in higher education and work place settings. Integrating and making STEM education the foundation of school programs is the first step in advancing STEM literacy (Bybee, 2010). Failure is eminent if STEM curriculum are not properly planned and executed.

Exposure to STEM curriculum in an elementary education setting could bridge this gap. STEM integrated classrooms could provide students with the problem-solving skills that encourage higher-level thinking and make learning more intrinsic to students. Currently, STEM federal funding is focusing more on science and mathematics and not placing emphasis on technology and engineering. For STEM to achieve its full potential, emphasis and integration must be placed on all four of the disciplines, not just science and mathematics. Technology and engineering programs in an elementary school setting are either lacking or nonexistent. According to Hanson, Burton, and Guam (2006), educators have varying opinions as to what represents effective technology education programs. ITEEA's *Standards for Technological Literacy: Content for the Study of Technology* (2007) states that content standard integration can be done easily at the elementary school level because there is only one teacher developing and delivering the lesson rather than having several teachers collaborate on one lesson plan such as those in middle or high school. STEM topics can easily be integrated into core academic subject material in an elementary school setting.

STEM integration can be achieved by eliminating the silo effect of teaching science, technology, engineering, and mathematics as separate disciplines. Integration of STEM concepts can be defined as combining these four disciplines into one fluid and dynamic methodology. STEM education transforms a typical teacher-centered classroom by encouraging curriculum that is driven by problem-based learning, exploratory learning and discovery, and

requires students to actively engage in an age-appropriate problem in order to find its solution. According to McLaughlin (2009), an elementary school classroom should integrate these disciplines so students can participate in solving problems that encourage original research.

Elementary classroom teachers typically develop and deliver their own lessons without having to collaborate with other teachers across other disciplines, which makes integration easier. Students could work directly with one teacher on solving a given problem. They could design, model, and test their solutions within their classroom. STEM can be implemented using an integrated STEM curriculum, partnerships with community stakeholders, partnerships with higher-education STEM programs, and most importantly, professional development for the teachers that will be teaching STEM content into their classrooms (McLaughlin, 2009). Schools that remain at the forefront of learning and training of STEM concepts will be the most successful in achieving STEM proficient students with readied science, technology, engineering, and mathematics skills for the global marketplace.

Currently, Virginia is ranked among the top five states by technology job growth in 2006. According to an April 2008 press release:

> Virginia's tech industry grew by four percent, adding 9,800 jobs for a total of 270,800 in 2006, the most recent year available. This is the third consecutive year of ranking among the top five states by tech job growth for Virginia. This growth helps solidify Virginia's placement as the state with the highest concentration of technology workers, with 9.1 percent of

> its private sector workforce in the tech industry. These jobs pay nearly twice as much as the average private sector job in Virginia. Virginia's growth is overwhelmingly attributable to its high-tech services sectors. The state's largest sector is computer systems design and related services which employs 119,100 people, up 10,300 jobs in 2006, which also was ranked 2nd nationwide, only after California. While Virginia's second largest sector, engineering services, added 700 net jobs. (para. 2)

Given these latest findings and a palpable advancement in technology careers in Virginia prompts the researcher to determine why STEM education is lacking in elementary school settings. ITEEA has developed *Standards for Technological Literacy: Content for the Study of Technology* (2007) for states to use in developing curriculum, yet Virginia has not implemented it. The question remains are Virginia public elementary school administrators and teachers receiving training on STEM educational practices and implementing them in their classrooms. For STEM programs to remain vital in schools, professional development that provides solid foundations in content and methods of STEM is crucial. Federal funding is available to implement STEM training and curriculum.

Determining what, if any, STEM education related workshops and training are offered to school administrators at an elementary school level is imperative. Ascertaining if administrators/teachers are requiring implementation of STEM curricula, instructional practices, or activities by elementary school teachers is imperative to this research and for students to become STEM proficient in Virginia.

STATEMENT OF THE PROBLEM

The problem of this study was to determine if public elementary schools have received STEM education related training that could be integrated into current instruction at this level.

RESEARCH QUESTIONS

The following research questions were developed not only to establish the boundaries for this study, but also to guide the researcher toward possible solutions to this problem.

RQ_1: Have administrators been exposed to STEM education training?

RQ_2: Are administrators requiring teachers to pursue STEM training?

RQ_3: Are administrators currently implementing STEM education initiatives in their school?

RQ_4: What STEM education related training do administrators believe could be implemented in their districts within the next five years?

BACKGROUND AND SIGNIFICANCE

The National Science Foundation (NSF) is an independent federal agency created by President Harry S. Truman. He signed the NSF legislation on May 10, 1950, creating a government agency that funds research in the basic sciences, engineering, mathematics, and technology (National Science Foundation, 2010). The NSF has found that teacher participation in professional development in mathematics and science at the elementary level was not as common as that at the middle and high school levels (National Science Foundation, 2010). On average, teacher participants spent about 14 hours on

staff development in mathematics and science during the entire school year (National Science Foundation, 2010). Virginia Department of Education requires its teachers to complete 180 professional development points within a five-year period based on an individualized professional development plan (Virginia Department of Education, 2007). This lack of training could be attributed to many things, one of which is lack of STEM content training opportunities for elementary education.

The National Science Foundation (2007) found that elementary school teachers often do not acquire sufficient STEM content knowledge or skills for teaching the content during their pre-service preparation. The need for districts to offer STEM education training opportunities for administrators and teachers at the elementary school level is crucial to the success of students moving into middle and high school.

The major reason for this study was to research central Virginia school districts training opportunities for elementary education in STEM content integration. Determining if STEM training is being offered and if the STEM training is reaching elementary school teachers is important to ascertain deficiencies in adequately preparing students to meet the needs of a global economy. Additionally, it is important to determine if elementary school administrators are seeing the need for STEM education initiatives in their school. Their plan of action is crucial to determine what school districts can do to integrate STEM curriculum and activities.

LIMITATIONS

The following limitations will affect the research in this study:

- The research was limited to current administrators which include Principals or Vice Principals.
- The population was limited to the Virginia Department of Education Region 1, Central Virginia, public elementary schools that include: Charles City, Chesterfield, Dinwiddie, Goochland, Hanover, Henrico, New Kent, Nottoway, Powhatan, Prince George, Surry, Sussex, and the cities of Colonial Heights, Hopewell, Petersburg, and Richmond.

ASSUMPTIONS

The assumptions included in this study were necessary to identify and clarify the problem. They served to establish a framework for those items that the researcher believed to be true with regard to the study. Virginia has not updated its curriculum consistently to incorporate the content standards contained within ITEEA's *Standards for Technological Literacy*. Virginia is found to be a former member of the ITEEA-CATTS consortium of states and it has also discontinued Standard of Learning Technology (instructional technology/ computer usage) testing in 2002 (DeMary, 2002). The researcher assumed that a lapse of this membership and no formal SOL testing in technology and engineering conveyed no formal commitment to plan for the implementation of standards-based technology and engineering curriculum. It was also assumed that since the NGA has supported six states including Virginia, in advancing state

STEM education policy agendas, administrators have had input to STEM education initiatives in their school (National Governors Association, 2011).

PROCEDURES

The procedural method for data collection in this study began with developing a questionnaire with specific items that will allow each elementary school respondent to reveal what STEM education related training has been received. The questionnaire explored future plans for STEM integration at the elementary school within the next five years. The questionnaire was mailed with an email notification to the participants and used to provide data needed for the study. The researcher used descriptive statistical methods for presenting the research study.

DEFINITION OF TERMS

This section provided for clarification of key terms and phrases that had special meaning in the study. The definitions of terms and phrases were specifically provided according to the context of this study.

AeA — An organization that was the nation's largest technology trade association representing all segments of the high-tech industry.

Administrator — This term refers to a Principal or Vice-Principal in charge of an elementary school within their respective public school district.

Content Standards — The standards in Standards for Technological Literacy: Content for the Study of Technology (ITEEA, 2007) that provide written statements of the knowledge and abilities students should possess in order to be technologically literate.

Engineering Literacy — Engineering literacy is the understanding of how technologies are developed via the engineering design process. They include lessons that are project-based and integrate multiple subjects.

Integration — The term integration is used to show the actual process of bringing academic disciplines into one course.

ITEEA — An acronym for International Technology and Engineering Educators Association. It is a professional organization for technology, innovation, design, and engineering educators. Members of the consortium of states provide a network of support and guidance for implementation of these educational programs.

NGA — An acronym for the National Governors Association. It is a professional organization for United States governors to share best practices, lessons learned, and have access to a number of NGA Center resources.

STEM — An acronym for Science, Technology, Engineering, and Mathematics. It is a concept term that integrates the academic disciplines through project-based learning.

Technology Literacy — Capacity to use, understand, and evaluate technology as well as to understand technological principles and strategies needed to develop solutions and achieve goals. It encompasses the three areas of Technology and Society, Design and Systems, and Information and Communication Technology (NAEP, 2010).

Technology — This term is defined as the innovation, change, or modification of the natural environment to satisfy perceived human needs and wants (ITEEA, 2004).

OVERVIEW OF CHAPTERS

This research is segmented into five major areas. Chapter I, Introduction, introduces the reader to the study which was designed to determine if STEM education related training was given to administrators and teachers at an elementary school level. The purpose of this study was to research the level of STEM training made available by school districts to their elementary schools and to determine the level of integration that is being made. Also discussed was the need for STEM education in the U.S. and why it is important for all students and teachers to further the STEM education initiative. Finally, it was discussed how integration of STEM initiatives at an elementary level are possible.

Chapter II, Review of Literature, will be organized and segmented according to the research goals. Also, prior research studies on STEM integration in elementary schools are examined.

Chapter III, Methods and Procedures, will describe the methods and procedures utilized to gather data. Also, this chapter will provide an explanation of the statistical methods used to interpret the data.

Chapter IV, Findings, will provide the results of the descriptive survey. The results will be organized and segmented by the response rate of the survey findings which were grouped in research question order.

Chapter V, Summary, Conclusions, and Recommendations, the researcher will summarize the research study and draw conclusions based on the data received. Finally, the researcher will make recommendations for future studies.

CHAPTER II

REVIEW OF LITERATURE

The purpose of this chapter was to review current literature on STEM integration at an elementary level. This chapter contains two sections. The first section will detail STEM literacy and STEM integration within the educational system focusing on elementary schools. The next section reviewed federal and state guidelines for funding STEM education and professional development at a K-12 level.

STEM LITERACY AND INTEGRATION

STEM integration begins with STEM literacy. STEM literacy, as defined by the NGA (2007), "refers to an individual's ability to apply his or her understanding of how the world works within and across four interrelated domains" (p. 7). These include science, technology, engineering, and mathematics. Bybee (2010) defines STEM literacy as, "involving integration of STEM disciplines and four interrelated and complementary components" (p. 31). STEM literacy encompasses scientific, technological, engineering, and mathematical foundations, when brought together, bridge the "silo" effect of teaching these disciplines separately. STEM integrated classrooms emphasize the importance of design and problem-solving skills.

Research has shown that STEM integrated curriculum increased learning in students. Hartzler (2002) conducted a meta-analysis of 30 studies on integrated curriculum programs and their effects on student achievement. The study showed that students in an integrative classroom consistently

outperformed students in a traditional classroom. Drake and Burns (2004) also support efficacy of integrated approaches. They concluded that students in integrated approaches showed consistent levels of academic success (Drake & Burns, 2004).

In his article, Advancing STEM Education: A 20/20 Vision, Bybee (2010), proposes a ten year plan for STEM integration. The initial phase in the integration would take place over two years and would focus on funding and development. Bybee (2010) believes that creating a positive impact on STEM integration and literacy starts by increasing the understanding and acceptance among school personnel, increased support by policy makers, and promoting understanding and support by the public. Included in this six year phase is professional development for teachers.

The next phase he calls “systematic changes that make a difference,” which brings reform (Bybee, 2010, p. 34). Throughout this process, professional development of STEM teachers continues. The final stage of STEM integration would include new standards and assessments, new teacher certification requirements, new materials for core and supplemental programs, and professional development of teachers that would be aligned with the new STEM priorities (Bybee, 2010).

Rogers and Portsmore (2004) have documented engineering integration at an elementary school level. They found that engineering has the advantage of providing hands-on experiences and promoting creative work. They also found that engineering concepts, when integrated correctly at an elementary level,

appeals to both boys and girls, a variety of learning styles, and multiple intelligences (Rogers et al., 2004). They have shown that integrating engineering curriculum at an elementary school level provides students with ways of applying, connecting, and reinforcing knowledge in mathematics, science, and design. Their research further highlights the fact that elementary school students can begin learning about physics, programming, and mathematics at a much earlier age than previously expected (Rogers et al., 2004). They have integrated engineering concepts that are easy enough for kindergartners to understand and continue to build upon through a student's elementary school life. They note that teachers can only successfully integrate these and other STEM concepts if they are properly trained and receive support in STEM areas.

STEM literacy and STEM integration go hand in hand. Although educators have different views on STEM integration, the research is clear: it has been shown that STEM integration increases students understanding of the core concepts of STEM education. Educators are either lacking the professional development to integrate STEM curriculum, or they have not been exposed to it at all. Bridging this gap is important to further the STEM movement.

FEDERAL AND STATE GUIDELINES FOR STEM FUNDING

On March 13, 2010, President Obama and his administration released a blueprint for revising the Elementary and Secondary Education Act (ESEA). This blueprint was an overhaul of the No Child Left Behind Act (NCLB) (U.S. Department of Education, 2011). The document chronicled how the federal government would provide incentives to state and local efforts that help ensure

students graduate prepared for college and a career. The Supporting Science, Technology, Engineering, and Mathematics Education section of 2010 ESEA Reauthorization: A Blueprint for Reform states, “mastery of mathematics, science and technology is no longer for future scientists and engineers; it is essential preparation for all students” (p. 1). The blueprint provides funding opportunities to further STEM integration into educational institutions at all levels.

The federal government proposed $300 million in grants to states, school districts, and non-profits for competitive STEM grants. The federal government also stated that in the President’s 2011 budget, $150 million of the Investing in Innovation fund will be centered on STEM projects (U.S. Department of Education, 2010). Furthermore, the Obama administration will double federal funding to ensure that teachers have access to high-quality preparation programs like those of STEM education. The Supporting Science, Technology, Engineering, and Mathematics Education section of 2010 ESEA Reauthorization: A Blueprint for Reform also states:

> Funding for districts to implement professional development that is relevant to student, teacher, and school needs has helped to provide teachers the knowledge and skills that help them improve classroom practice, including developing content knowledge in STEM fields. The proposal will provide more support for time for teacher collaboration, mentoring, and working together to improve practice. (p. 3)

The blueprint further proposes financial assistance to states that strengthen their STEM programs. States are not only going to be required to

develop comprehensive and evidence-based plans, but they will have to align federal, state, and local funds to provide high-quality STEM instruction. The Complete Education section of 2010 ESEA Reauthorization: A Blueprint for Reform States will award competitive sub-grants to districts whose programs provide effective professional development for teachers and school leaders.

The National Science Foundation funds research and education in most fields of science and engineering. The NSF also supports cooperative research between universities and industry, US participation in international scientific and engineering efforts, and educational activities at every academic level (NSF, 2010). Grants and cooperative agreements are awarded to more than 2,000 colleges, universities, K-12 school systems, businesses, informal science organizations, and other research organizations throughout the United States (NSF, 2010). According to the NSF (2010), they account for about one-fourth of federal support to academic institutions for basic research. They receive approximately 40,000 proposals each year in addition to several thousand applications for graduate and postdoctoral fellowships. These proposals include research, education, and training projects, of which approximately 11,000 are funded.

At a state level, the National Governors Association (NGA) (2011), which currently includes a total of 33 states in its membership, stated on their website, “governors can elevate the urgency and build the political will to advance STEM education and use budgetary and policy levers to make meaningful changes across education systems” (para. 5). The NGA (2011) believes that state

governors have the ability to advance comprehensive STEM education policy agendas. Over the last two years, the NGA has supported six states, Colorado, Hawaii, Minnesota, Ohio, Pennsylvania, and Virginia, in advancing state STEM education policy agendas (National Governors Association, 2011).

Federal and state funds are available to educational institutions for STEM integration and professional development of their personnel in STEM related areas. The Race to the Top partnership is just one way the Obama administration is supporting STEM education. States are working to bring STEM education to their schools because they not only see the immediate need, but they also see the benefits that STEM education can bring to students as they continue through college and career.

SUMMARY

STEM education can only be integrated in schools if personnel are either certified in STEM or they received proper training to integrate it into their existing curriculum. There is no guide or organization that oversees STEM professional development. This responsibility will fall on the schools and districts that the teacher works. If Bybee's (2010) integration plan is followed, then there should be STEM standards in the future.

STEM integration is imperative if we are to succeed in eliminating the silos of science, mathematics, engineering, and technology teaching. We can achieve this through STEM literacy and development of teachers in STEM subject matter. Although integration of STEM curricula in elementary schools has been shown to be easiest to integrate because there is only one teacher teaching the

curriculum, there is limited research to show how integration of STEM in elementary schools is being done. Also, there is limited research of available STEM training for administrators and educators of elementary school students to help implement STEM curricula in their schools at a K-6 level.

The federal government's overhaul of No Child Left Behind, Elementary and Secondary Education Act (ESEA), will provide funding for STEM initiatives. The Obama Administration provided a blueprint to how funding can be used. States can use these guidelines to further their STEM integration plans in their educational institutions. The NSF can also serve as a guide and funding source for STEM initiatives.

Chapter III, Methods and Procedures, will describe the methods and procedures utilized to gather data. Also, this chapter will provide an explanation of the statistical methods used to interpret the data.

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CHAPTER III

METHODS AND PROCEDURES

The focus of this study was to determine training and professional development opportunities for teachers and administrators at an elementary level in STEM integration. Ascertaining if STEM training is being offered and if it is reaching elementary school teachers is important to define deficiencies in adequately preparing students to meet the needs of a global economy. Additionally, it is important to determine if elementary school administrators are acknowledging the need for STEM education initiatives in their school. Their plan of action is crucial to determine what school districts can do to integrate STEM curricula and activities into their schools. The instrument used determined what, if any, STEM training at the administrator and teacher levels are being taken and implemented. Additionally, this chapter will provide an explanation of methods of data collection and a description of the planned statistical analysis.

POPULATION

The population for this study consisted of 159 elementary school administrators within their respective Virginia public school districts. The public school districts that composed the population were the following 16 cities and counties: Charles City, Chesterfield, Dinwiddie, Goochland, Hanover, Henrico, New Kent, Nottoway, Powhatan, Prince George, Surry, Sussex, and the cities of Colonial Heights, Hopewell, Petersburg, and Richmond. The elementary schools are part of the Virginia Department of Education Region 1, Central Virginia, and were found using the following source: *Virginia Department of Education Virginia*

Public School Division Staff – By Region (Virginia Department of Education, 2011). For a list of the elementary schools surveyed see Appendix A.

INSTRUMENT DESIGN

The problem of this study was to determine if public school administrators and/or their teachers have received STEM education related training that could be integrated into current instruction at an elementary school level. To guide the researcher towards a solution to this problem, a questionnaire was developed to collect data from the 159 elementary school administrators.

The survey combined force choice responses and open formed questions. Survey Questions 1, 2, 3, 4, 5, 6, and 8 used the five-point Likert scale to express their degree of agreement or disagreement with the questions through answer selection. Answer choices were “Very High” which had a value of 5, “High” which had a value of 4, “Moderate” which had a value of 3, “Low” which had a value of 2, and “Very Low” which had a value of 1.

Survey Questions 1 and 2 were written to address Research Question 1, *Have administrators been exposed to STEM training*. Survey Question 1 determined the respondent’s knowledge of STEM education and implementation. Survey Question 2 sought to determine the level of influence STEM was having on the respondents training within their individual district.

Research Question 2, *Are administrators requiring teachers to pursue STEM training*, was addressed by Survey Questions 3 and 4. Survey Question 3 looked at the degree of endorsement each administrator had for their teachers regarding STEM training and development. Survey Question 4 determined the

level of requirement the respondent's have for their teacher's pursuing STEM related training.

Research Question 3, *Are administrators currently implementing STEM initiatives in their schools*, was addressed by Survey Question 5, 6, and 7. Survey Questions 5 and 6 determined the current school-level implementation of STEM integrative concepts and activities, including time required for classroom teachers to currently implement STEM initiatives in their classroom. Survey Question 7 used a force choice response of which respondents selected the answer that best described the percentage of time classroom teachers used in implementation of STEM initiatives or activities on a weekly basis.

Survey Questions 8, 9, and 10 were used to address Research Question 4, *What STEM related training do administrators believe can be implemented in their districts within the next five years*. Survey Question 8 asked respondents to rate the degree of which they felt STEM should be implemented in their schools within the next five years. Survey Question 9 used a force choice response to describe the most important STEM initiatives for the respondent's school in the next five years. Finally, Survey Question 10 required information in open-form. The respondents had to list changes that need to occur to effectively incorporate STEM concepts in their schools in the next five years. Appendix B shows the instrument used in this research study. Table 1 shows how the Survey Questions correlate with each Research Question posed.

Table 1

Research Questions and Survey Correlations

Research Questions	Corresponding Survey Questions
Have administrators been exposed to STEM education training?	1. How would you rate **your knowledge** of STEM education and its implementation? 2. Is the concept of STEM **influencing** professional development and training programs in your school?
Are administrators requiring teachers to pursue STEM training?	3. To what degree have you **endorsed STEM training or STEM professional development for your teachers** in the last two years that could be implemented into your school? 4. What **level of requirement** do your teachers have in pursuing STEM related training?
Are administrators currently implementing STEM education initiatives in their school?	5. How would you rate your school's **current implementation of STEM integrative concepts** and activities? 6. As an administrator, how much time **do you require classroom teachers to currently implement** STEM initiatives in their classroom? 7. What percentage of time would you estimate that your classroom teachers devote to **implementing STEM initiatives or activities** in their classroom per week?
What STEM education related training do administrators believe could be implemented in their districts within the next five years?	8. To what degree do you believe that STEM related training should be **integrated in your school within the next five years**? 9. Of the options listed below, which STEM initiatives are **most important for your school in the next five years?** 10. What changes need to occur to **effectively incorporate STEM concepts** into your elementary school **in the next five years**?

METHODS OF DATA COLLECTION

The method of data collection used for this study was notification of the impending survey by electronic mail and survey delivery by regular mail. The surveys were distributed along with a cover letter (Appendix C) to the 159 elementary school administrators identified. The cover letter explained the purpose and the importance of the survey and guaranteed the respondent's confidentiality. Respondents were given 10 days to complete and return the questionnaire. To ensure the highest possible response rate, non-responses

were sent a follow-up letter, additional survey, and were followed up by telephone methods.

STATISTICAL ANALYSIS

Upon receipt of the surveys, the researcher used descriptive statistical methods to organize, tabulate, and interpret the collected data. The data compiled from the returned questionnaires used the number of responses, frequency of answers, and means to statistically analyze the data. The frequency and number of responses were calculated and a percentage obtained to determine the results. Additionally, the open-ended questions were reviewed and recorded according to similarities.

SUMMARY

Chapter III, Methods and Procedures, described population, instrument design, methods of data collection, and statistical analysis procedures used in this study to answer the research problem. Procedural methods for collecting data began by identifying the population of public elementary school administrators from the Central Virginia, Region 1 Public School Districts. The method of data collection employed was a survey that was developed with specific items that allowed measurement of STEM education related training and integration plans into elementary schools as provided by the survey respondents. Descriptive statistical steps and techniques to analyze and interpret the research data were discussed.

Chapter IV, Findings, will provide the results of the descriptive survey. The results will be organized and segmented by the response rate of the survey findings which were grouped in research question order.

CHAPTER IV

FINDINGS

This chapter presented an analysis of the data collected from the *STEM Training & Integration for Elementary School Personnel*, a survey designed to measure respondent awareness of STEM related training and integration at an elementary school level. Subsections were established by response rate and survey questions in research question order. The problem of the study was to determine if public elementary schools have received STEM education related training that could be integrated into current instruction at this level.

RESPONSE RATE

STEM Training & Integration for Elementary School Personnel Surveys were sent to 159 principals using direct mail methods on April 25, 2011. Initial response rates were low, therefore follow-up methods including follow-up letters, telephone calls, email, and personal visits were needed to increase response rates. The data collection period spanned from April 25 through June 15, 2011. Of the one 159 administrators surveyed, 38 indicated they did not want to participate in the survey. Sixty percent of the population, or 73 out of 121 principals, participated in the survey research. The researcher received 57 questionnaires from direct mail methods, 12 electronically, and four via personal visits. All data collection methods have been consolidated as a total response rate percentage. Despite various follow-up methods, 48 questionnaires were not received by the study deadline. Table 2 shows the response rate.

Table 2

Response Rate

Number Sent	Administrators Who Did Not Want to Participate	Number Collected	Total Response Rate
159	38	73	60.33 %

REPORT OF FINDINGS

The findings from the survey questions were reported with respect to applicable research questions. A narrative description for each aggregated question response was provided. Due to a 60.33 percent response rate, which is not at the .05 significance level, data analysis figures were deemed insufficient to represent a larger population of elementary school administrators. Despite the occasional non-response, none of the data items presented for analysis had an aggregate response rate below 83.56 percent. The researcher used descriptive statistical methods to organize the data. The data compiled from the returned surveys reported number of responses, frequency of answers, and mean to statistically analyze and aggregate data.

Elementary Administrator STEM Training

Research Question 1 was *Have administrators been exposed to STEM education training?* To answer this question, survey Questions 1 and 2 were designed to measure respondent exposure to STEM education training. Likert scale values assigned to each response ranged from zero points for “did not respond” to five points for “very high” and used for calculation of the mean. If the

principals failed to answer the question, the population (n value) was reduced, not to affect the mean.

In Question 1, principals were asked to rate their knowledge of STEM education and its implementation. Of the 73 principals who responded, the mean was calculated as 2.82, which indicated moderate knowledge of STEM education. While 24.66 percent (n = 18) rated themselves in categories above the mean, approximately 34.25 percent (n = 15) of the principals rated their knowledge level below the mean. Additionally 30 of 73 principals (41.1%) determined their programs around the mean. The Likert scale frequency of responses and percentage of answers for Question 1 were presented in Table 3.

In Question 2, principals were asked if STEM was influencing professional development and training programs in their school. Seventy-one of the 73 principals responded to this question. The mean response was calculated as 2.58, which indicated moderate influence of STEM on training and professional development. While 23.95 percent (n = 17) rated themselves in categories above the mean, 49.3 percent (n = 35) of principals rated their knowledge level below the mean. Furthermore, 19 of 71 principals (26.76%) determined their programs approximately the mean. The Likert scale frequency of responses and percentage of answers for Question 1 were presented in Table 3.

Question 2 had an open area for comments of where twenty principals provided comments. Twelve of the 71 principals (16.90%) provided comments that showed STEM is influencing professional development and training programs in their schools. For example, one principal said “I plan to increase already present

Table 3

Administrative STEM Knowledge

	Did not respond	Very Low	Low	Moderate	High	Very high	M
	f (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)	
Q #1	0 (0.00)	6 (8.22)	19 (26.03)	30 (41.10)	18 (24.66)	0 (0.00)	2.82
Q #2	2 (2.74)	13 (18.31)	22 (30.99)	19 (26.76)	16 (22.54)	1 (1.41)	2.58

Note. *f* = frequency of response; *%* = percentage (rounded two decimal values); total number of principals, n = 73; *M* = mean (rounded two decimals).

efforts to integrate STEM effectively." Eight of the 71 principals (11.27%) indicated they had little or no knowledge if STEM was influencing professional development and training programs in their schools. Table 4 indicates clustered responses:

Table 4

Open-Form Responses Regarding STEM Influence

Q# 2 Clustered Responses
• STEM is influencing professional development and training programs in their schools (n = 12) • Little or no knowledge that STEM influencing professional development and training programs in their schools (n = 8)

Note. Elementary principal comments, n = 20

Administrator STEM Requirements

Research Question 2 asked *Are administrators requiring teachers to pursue STEM training?* To answer this question, survey Questions 3 and 4 were designed to measure a principal's requirement of teachers to pursue STEM related training. Likert scale values assigned to each response ranged from zero

points for “did not respond” to five points for “very high” and used for calculation of the mean. If a principal failed to answer the question, the population (n value) was reduced, not to affect the mean.

In Question 3, principals were asked to what degree they have endorsed STEM related training or STEM professional development for their teachers in the last two years. Seventy-two out of 73 principals responded to this question. The mean response was calculated as 2.63, which indicated moderate endorsement. Whereas 26.39 percent (n = 19) rated themselves in categories above the mean, 44.44 percent (n = 32) of principals rated their knowledge level below the mean. Additionally, only 21 of the 72 principals (28.77%) that responded determined their endorsement of STEM to be approximate the mean. The Likert scale frequency of responses and percentage of answers for Question 3 were presented in Table 5.

In Question 4, principals were asked what level of requirement their teachers had in pursuing STEM training. Seventy-three principals responded to this question. Responses showed the mean as 2.29, which indicated a low level of requirement for teachers to pursue STEM training. Although 41.10 percent (n = 30) rated themselves in categories above the mean, 26.03 percent (n = 19) of principals rated their requirement level for teachers pursuing STEM training below the mean. Twenty-four of 73 principals (32.88%) determined their programs approximate the mean. The Likert scale frequency of responses and percentage of answers for Question 4 were also presented in Table 5.

Table 5

Administrative STEM Requirement for Teachers

	Did not respond	Very Low	Low	Moderate	High	Very high	M
	f (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)	
Q #3	1 (1.37)	15 (20.83)	17 (23.61)	21 (29.17)	18 (25.00)	1 (1.39)	2.63
Q #4	0 (0.00)	19 (26.03)	24 (32.88)	11 (28.77)	8 (10.96)	1 (1.37)	*2.*58

Note. *f* = frequency of response; *%* = percentage (rounded two decimal values); total number of principals, n = 73; *M* = mean (rounded two decimals).

Question 3 had an open area for comment of which 18 principals (25.00%) provided responses regarding their level of endorsement for STEM related training. Three principals (4.17%) indicated a need for additional information to require STEM related training for their teachers. Responses also indicated that 15 (20.83%) principals have encouraged and required teachers to pursue training. One principal stated, "I support the idea and do my best to move teachers in this direction despite the challenges." Table 6 shows clustered responses.

Table 6

Open-Form Responses Regarding STEM Training Endorsement

Q# 3 Clustered Responses
• Needs to know more about the program (n = 3) • Encouraged teachers to engage in professional development (n =15)

Note. Elementary principal comments, n = 18

Question 4 provided 13 comments by principals (17.81%). Eight principals (10.96%) indicated there was little or no requirement for their teachers

to pursue STEM related training. Five principals (6.85%) indicated that there was a requirement for teachers to pursue current and future STEM training. One principal stated, “change the standards so students can do more STEM learning activities,” while another said “there needs to be renewed teacher commitment so that they can try new ways to work with students”. Table 7 indicates clustered responses.

Table 7

Open-Form Responses Regarding STEM Training Requirements

Q# 4 Clustered Responses
• Little or no requirement (n = 8) • They have been required to attend sessions on STEM (n = 5)

Note. Elementary principal comments, n = 13

Administrative STEM Implementation

Research Question 3 asked *Are administrators currently implementing STEM education initiatives in their school?* To determine the response to this question, survey Questions 5, 6, and 7 were designed to measure a principal’s current integration of STEM education initiatives in their schools. Likert scale values were assigned to each response to range from zero points for “did not respond” to five points for “very high” and used for calculation of the mean on Questions 5 and 6. Likert scale values were also assigned to Question 7 to range from zero points for “did not respond” to five points for “over 75% of the time” and used for calculation of the mean. If a principal failed to answer the question, the population (n value) was reduced, not to affect the mean.

In Question 5, principals were asked to rate their schools current implementation of STEM integrative concepts and activities. Seventy-three principals responded. The mean response was calculated as 2.39 which indicated a low rate of implementation of STEM concepts and activities. Responses showed 47.95 percent (n = 35) of principals rated themselves in categories above the mean while 23.29 percent (n = 17) rated their implementation level below the mean. Twenty-one of 73 principals (28.77%) rated their implementation level approximate the mean. The Likert scale frequency of responses and percentage of answers for Question 5 were presented in Table 8.

In Question 6, principals were asked if they required classroom teachers to currently implement STEM initiatives in their classrooms. Seventy-one of the 73 principals indicated a response. The mean response was calculated as 2.31, which indicated a low level of requirement for classroom teachers to implement STEM lessons in their classes. Although 45.05 percent (n = 32) rated themselves in categories above the mean, 28.17 percent (n = 20) of principals rated their knowledge level below the mean. Furthermore, only 19 of 71 principals (26.76%) determined their programs approximate the mean. The Likert scale frequency of responses and percentage of answers for Question 6 were presented in Table 8.

Question 7 asked principals to estimate the amount o time their classroom teachers devoted to implementing STEM initiatives or activities in their classroom each week. Principals were given the choices of 0% of the time, 0% to 25% of the time, 25% to 50% of the time, 50% to 75% of the time, and over 75% of the

time. Seventy-one principals provided a response to this question. The mean response was calculated as 2.29, which indicated a low percentage of time, or 0% to 25% of the time per week. While 33.80 percent (n = 24) rated themselves in categories above the mean, or more than 25% of time spent on STEM related activities, 15.49 percent (n = 11) of principals rated their time estimates below the mean. Furthermore, 36 principals (28.77%) indicated the time spent by their teachers for weekly implementation of STEM activities approximate the mean. The Likert scale frequency of responses and percentage of answers for Questions 5 were presented in Table 8.

Table 8

Administrative STEM Implementation

	Did not respond	Very Low	Low	Moderate	High	Very high	M
	f (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)	
Q #5	0 (0.00)	17 (23.29)	21 (28.77)	25 (34.25)	10 (13.70)	0 (0.00)	2.39
Q #6	2 (2.74)	20 (28.17)	19 (26.76)	23 (32.39)	8 (11.27)	1 (1.41)	2.31
Q #7	2 (2.74)	11 (15.49)	36 (50.70)	17 (23.94)	6 (8.45)	1 (1.41)	2.29

Note. *f* = frequency of response; *%* = percentage (rounded two decimal values); total number of principals, n = 73; *M* = mean (rounded two decimals).

Question 6 provided an open area for comment of which 14 (19.72%) principals provided observations regarding their level of requirement for STEM implementation in their schools. Eight principals (11.27%) held a high-level of requirement for their teachers to implement STEM lessons. One principal said, “I require our STEM team to implement STEM initiatives at all times.” Of the 14 principals that provided comments, five principals (7.04%) indicated that there was little or no requirement placed on teachers to implement STEM initiatives.

One principal stated, “if teachers were trained, the expectation would be higher.” Table 9 indicates clustered responses.

Table 9

Open-Form Responses Regarding STEM Classroom Requirement

Q# 6 Clustered Responses
• Encouraged. Very High (n = 8) • No specific requirements are in place (n = 5) • Science/Math/Technology Integration (n = 1)

Note. Elementary principal comments, n = 14

Eleven (15.49%) principals provided comments on Question 7 regarding time estimates for teachers implementing STEM initiatives or activities in their classroom per week. Eight principals (11.27%) stated that teachers are encouraged to implement STEM lessons weekly. One principal said, “The STEM team devotes many hours to STEM initiatives over the course of the week.” Of the 11 principals that provided comments, two (2.82%) indicated they had little knowledge of the program and one (1.41%) had no STEM program at all. Table 10 indicates clustered responses.

Table 10

Open-Form Responses Regarding Time Spent Weekly on STEM Activities

Q# 7 Clustered Responses
• Activities and lessons related to STEM are implemented (n = 8) • Not enough knowledge to answer (n = 2) • No STEM Program (n = 1)

Note. Elementary principal comments, n = 13

Possible STEM Training in the Next Five Years

Research Question 4 was *What STEM education related training do administrators believe could be implemented in their districts within the next five years?* To answer this question, survey Questions 8, 9, and 10 were designed to measure a principal's point of view regarding future STEM training. Likert scale values were assigned to each response to range from zero points for "did not respond" to five points for "very high" and used for calculation of the mean on Question 8. For survey Question 9, frequency was used to measure a principal's position towards STEM integration in the future. Finally, Question 10 used an open-form response format for principals to indicate changes needed to effectively incorporate STEM in their schools in the next five years.

Principals in Question 8 were asked to what degree they believed that within the next five years that STEM related training should be integrated in their schools. The mean response was calculated as 3.77, which indicated that principals believed to a high degree that STEM training should be integrated in their schools in the next five years. Although 17.14 percent (n = 12) rated themselves in categories above the mean, 30.01 percent (n = 21) of principals were below the mean. In addition, 37 principals (52.86%) provided responses approximate the mean. The Likert scale frequency of responses and percentage of answers for Question 8 were presented in Table 11. Question 8 provided principals an open-form area to list any specific STEM or engineering programs their teachers or themselves had participated. Eighteen (25.71%) principals provided comments on Question 8. Thirteen principals (18.57%) stated that they

Table 11

Possible STEM Training in the Next Five Years

	Did not respond	Very Low	Low	Moderate	High	Very high	M
	f (%)	*f* (%)	*f (%)*	*f* (%)	*f* (%)	*f* (%)	
Q #8	3 (4.29)	2 (2.86)	3 (4.29)	16 (22.86)	37 (52.86)	12 (17.14)	3.77

Note. *f* = frequency of response; *%* = percentage (rounded two decimal values); total number of principal, n = 73; *M* = mean (rounded two decimals).

or their teachers had attended the Children's Engineering training program. One principal stated, "STEM is the way to go with 21st century learning." Another principal stated that they "are currently developing a school-wide focus with help from Virginia State University." Four principals (5.71%) indicated they did have some professional development that was STEM related, and one principal (1.43%) indicated they had no STEM related training. Table 12 indicates consolidated responses.

Table 12

Open-Form Responses Regarding Specific STEM Programs

Q# 8 Clustered Responses
• Children's Engineering (n = 13) • STEM related programs (n = 4) • No STEM related training (n = 1)

Note. Elementary principal comments, n = 18

Question 9 asked principals to indicate which STEM initiatives were most important for their school in the next five years. The options included STEM integration and implementation strategies, STEM curriculum, STEM professional development, and STEM community/institution partnerships. Principals could

select any or all of the options listed for their response. A total of 155 options were chosen. Professional development ranked as the highest choice of the four given, chosen 58 times (37.42%), while STEM integration and implementation strategies followed closely being chosen 54 times (34.84%). STEM curriculum was third, chosen 25 times (16.13%), and STEM community/institution partnerships was last, being chosen 18 times (11.61%). The frequency of responses and percentage of answers for Question 9 were presented in Table 13.

Table 13

STEM Initiative Options

	Did not respond	STEM Integration & Implementation Strategies	STEM Curriculum	STEM Professional Development	STEM Community/ Institution Partnerships
	f (%)	*f* (%)	*f* (%)	*f* (%)	*f* (%)
Q #9	2 (1.29)	54 (34.84)	25 (16.13)	58 (37.42)	18 (11.61)

Note. *f* = frequency of response; % = percentage (rounded two decimal values); total number of choices marked, n = 73 (155 choices marked).

Four (5.63%) principals provided comments on Question 9 regarding STEM integration and implementation strategies, STEM curriculum, STEM professional development, and STEM community/institution partnerships. Two principals (2.82%) believed that all the options were important to truly benefit from what STEM has to offer, while one principal (1.41%) placed emphasis only on professional development. One principal (1.41%) stated they had several partnerships in the private sector as well as university-based partnerships. Table 14 indicates clustered responses.

Table 14

Open-Form Responses Regarding STEM Options

Q# 9 Clustered Responses
• All are important to truly benefit from what STEM has to offer (n = 2)
• Emphasis on professional development (n = 1)
• Have many partnerships in private sector as well as universities (n = 1)

Note. Elementary principal comments, n = 4

Question 10 asked principals in open-form to list changes that needed to occur in order to effectively incorporate STEM concepts into their elementary school in the next five years. A wide array of answers was received from 61 (83.56%) of the 73 principals. Twenty-seven principals (44.26%) stated that staff/ professional development was important in implementing STEM initiatives in the next five years. State and local initiatives were the next change that needed to occur to further implement STEM according to nine principals (14.75%) followed by additional information on STEM initiatives according to eight principals (13.33%). Five principals indicated funding (8.33%) and additional teacher/administrative support (8.33%) as changes that need to occur. Technology needs were stated by four principals (6.67%) and two principals (3.33%) claimed that time was an important change that needed to occur. Finally, one principal (1.64%) said community support was an important change that needed to occur. Table 15 lists consolidated responses for Question 10.

Table 15

Open-Form Responses for Changes to Implement STEM in the Next Five Years

Q# 10 Clustered Responses

- **Staff/Professional Development** (n = 27)
  - Ongoing staff development is key
  - Continued training, additional materials
  - Additional professional development for teachers about engineering. We are on a three year plan related to technology.
  - Curriculum rewrite, professional development, assessments
  - Staff development to directly correlate to SOLS
  - Teachers will need more knowledge of STEM and Training
  - More professional development and discussion of effective teaching and learning; STEM excitement!
  - Professional Development
  - District wide initiatives and staff development
  - Specific professional development and implementation design and expectations
  - More professional development, more funding for STEM initiatives
  - Training, retraining and monitoring, implementation of STEM related activities
  - Provide professional development for staff, provide time to collaborate with others
  - We need to engage in systematic professional development
  - Our division needs to embrace STEM to include professional development and curriculum
  - More clarification and professional development on goals and objectives of the STEM project. Also provide a curriculum designed to incorporate activities using STEM
  - Staff development in integration & implementation will be critical
  - More training across curricular and how to incorporate STEM
  - More access to technology tools and ongoing professional development
  - Staff development for elementary teachers, increased community and institution partnerships to reinforce relevance
  - Focus on integration across content and systematic professional development for teachers
  - Ongoing availability and resources to provide development and follow-up implementation for teachers
  - More staff development and continued support from the SB…we are participating in a grant that targets 4th & 5th grades; however we have managed to instill enthusiasm in all other grades as well

Table 15 (*continued*)

Open-Form Responses for Changes to Implement STEM in the Next Five Years

Q# 10 Clustered Responses

- The district has not offered or required any STEM training for my staff. It would need to come from the district. I believe it is an excellent integrative curriculum of strategies and practice
- Continued professional development of instructional integration into the already demanding curriculum
- Professional development and monitoring by administrators
- Staff development and funding

- **State/Local Standards** (n = 9)
  - Incorporate STEM into SOLS
  - A reduction in standard testing
  - More staff development, less emphasis on AYP, subgroups scores and data regarding reading, writing, math
  - Many of the principles STEM correlate with 21st century skills: problem solving, inquiry, project, and problem-based learning. Such skills need to become more intertwined with the current content, specific standards, SOLs in order to effectively prepare our students for a global society
  - As a division we need more flexibility in our scheduling. STEM lessons integrate math and science concepts, this sometimes takes more than the block assigned to teachers
  - District endorsement
  - Local initiatives
  - We would have to make significant changes in the testing program and find ways to measure skills and concepts associated with STEM, especially in lower performing schools, where SOL testing prep is the major and sometimes only focus
  - The federal and state departments of education need to decide what is more important for students to learn. Teachers cannot teach everything

- **Additional Information on STEM** (n = 8)
  - We have done children's engineering but have not incorporated STEM directly. More info would be helpful
  - I do not know enough about STEM to respond
  - More information, more training and more support for exploratory learning vs. teach for testing conduct
  - We are not very familiar with STEM overall
  - How do we find out more about the program? Could it be called something else?
  - Our school does not have this program. I am interested in finding out more information on STEM

Table 15 (*continued*)

Open-Form Responses for Changes to Implement STEM In The Next Five Years

Q# 10 Clustered Responses

- We need to be introduced to the STEM program and see how it overlaps with Children's Engineering and Problem Based Learning. Once the three get together, we can move forward
- We don't use the term STEM, but we do all of the things your definition entails, as a result of being a national expeditiary learning school, because of our commitment to inquiry-based instruction.

- **Funding** (n = 5)
  - Would like to add a Lego Robotics team (FLL), however funding is an issue.
  - Funding also plays a role in the amount of children's engineering projects.
  - Training must ensue, financial support to make certain that materials and supplies are readily available
  - PTA helps to fund extracurricular/classroom actives that could be related to STEM activities.
  - Training for teachers and parents, funding

- **Teacher/Administrative Support** (n = 5)
  - A willingness and understanding by the teachers to see the benefits of a STEM program
  - [The] county is already a great job of providing us with STEM concepts through [county program] lessons and Children's Engineering training opportunities. The teachers and students are really enjoying this new focus for teaching and learning
  - A new principal will be serving our school next year
  - I will not be returning, so a new principal will have to take on this program

- **Technology** (n = 4)
  - Technology needs to be improved. A STEM course needs to be part of the school master schedule during the school day each day.
  - Major upgrade to technology
  - Keep technology up, running and updated
  - Additional Promethean boards, maintain STEM lab based on school space

- **Time** (n = 2)
  - More time
  - Time, AYP mandates lifted, training

Table 15 (*continued*)

Open-Form Responses for Changes to Implement STEM In The Next Five Years

Q# 10 Clustered Responses

- **Community Support** (n =1)
  - Establishment of a strong community partnership, the willingness of staff to seek outside support

Note. Elementary principal comments, n = 61

SUMMARY

In this chapter, the researcher reported the findings regarding STEM training and integration for elementary school personnel. The response rate was 60.33 percent, or 73 of 121 principals providing survey responses. It was determined that elementary school principals have moderate knowledge of STEM and in addition, professional development within their districts is being moderately influenced by STEM related concepts. Principals stated they have moderately supported STEM training or professional development for their teachers within the last two years. Although there is a moderate endorsement of STEM related training by principals, responses showed 58.90 percent of principals had a low or very low level of requirement for elementary teachers to pursue STEM related training. Consequently, principals rated their current level of STEM implementation in their schools as low with a mean of 2.39. Principals also indicated a low level of requirement (mean of 2.31) for teachers to currently implement STEM initiatives in their classrooms and as a result, 65.27 percent of principals indicated their teachers spent less than 25 percent of their class time implementing weekly STEM activities in their classrooms. However, principals

believed to a high degree (mean of 3.77) that STEM related training should be integrated in elementary schools in the next five years and that STEM professional development was the most important initiative to facilitate the implementation of STEM in the next five years.

In Chapter V, Summary, Conclusions, and Recommendations, the researcher will present a summary of the research findings. In addition, conclusions will be drawn based on reported data to answer the four research questions which guided this study. This will be followed by a review of recommendations and proposals for future studies and research.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

STEM skills are in strong demand in current global marketplace. By implementing STEM in elementary schools, students have additional time to master science, technology, engineering, and mathematics skills throughout their K-12 academic experience rather than just in high school specialty centers. Elementary school students can also greatly benefit from receiving STEM education in their schools because the additional time allows them to build a stronger STEM foundation, better understand STEM related concepts, and it allows students to become better problem-solvers. STEM education has the ability to transform a typical teacher-centered classroom by encouraging curriculum that is driven by problem-based learning, exploratory learning and discovery, and requires students to actively engage in age-appropriate problems in order to find their solutions.

This study emerged from a need to develop awareness in elementary schools toward the benefits that STEM concepts can offer students at an early age. Furthermore, the researcher sought to understand the level of STEM education awareness amongst elementary school principals, their beliefs regarding the implementation of STEM, and changes needed to occur within the next five years to further STEM education in their respective district and school. The purpose of this chapter was to summarize the research study and draw conclusions based on the responses received. Finally, the researcher will make recommendations for future considerations of this research problem.

SUMMARY

The problem of this study was to determine if public elementary schools have received STEM education related training that could be integrated into current instruction at this level. The following research questions were developed not only to establish the boundaries for this study, but also to guide the researcher toward possible solutions to this problem.

RQ_1: Have administrators been exposed to STEM education training?

RQ_2: Are administrators requiring teachers to pursue STEM training?

RQ_3: Are administrators currently implementing STEM education initiatives in their school?

RQ_4: What STEM education related training do administrators believe could be implemented in their districts within the next five years?

In researching STEM education, the researcher found that STEM education in Virginia is mostly implemented at a high school level. This prompted the researcher to determine if elementary school administrators believed implementation of STEM curricula, STEM instructional practices, or STEM activities by teachers in elementary schools could make students more STEM proficient in Virginia. Additionally, determining what changes need to occur in the next five years for STEM curricula to be implemented at an elementary school level was important to this study. In determining why STEM is not prevalent in elementary schools, the researcher collected surveys that described elementary school principal's current thoughts on STEM. In addition,

this study discussed actions and activities that enabled principals and teachers to implement STEM in elementary schools.

There were some limitations to this study. The limitations include the following:

- The research was limited to current administrators which include Principals or Vice Principals.
- The population was limited to the Virginia Department of Education Region 1, Central Virginia, public elementary schools that include: Charles City, Chesterfield, Dinwiddie, Goochland, Hanover, Henrico, New Kent, Nottoway, Powhatan, Prince George, Surry, Sussex, and the cities of Colonial Heights, Hopewell, Petersburg, and Richmond.

Data collection efforts consisted of surveying 159 elementary school principals within the Virginia Department of Education Region 1, Central Virginia. The researcher developed a 10-item survey to collect data. This survey allowed for principals to detail their awareness of and current implementation of STEM related training at an elementary school level. On April 25, 2011, the researcher sent a survey packet to each of the 159 elementary school principals, which contained a survey, a personalized cover letter, and a postage-paid return envelope. The cover letter explained their role in the research and that participation was voluntary. Survey collection efforts concluded on June 15, 2011. Of the 159 principals surveyed, 38 stated they did not want to participate in the study, 73 provided completed surveys (60.33%), and 48 principals did not respond at all after various attempts were made to reach them.

CONCLUSION

The researcher attempted to determine what STEM related training had elementary school principals and teachers received that could be integrated in their schools. There were four research questions that guided the study:

Research Question 1: Have administrators been exposed to STEM education training? The researcher found that there was moderate to low knowledge of STEM at an elementary school level. Of the 73 respondents, 75.35 percent ranked their knowledge of STEM moderate, low, or very low. The researcher also found that 76.06 percent of respondents rated their district moderate, low, or very low in regards to STEM influencing training and professional development in their district. This leads the researcher to determine that there is not enough STEM exposure at an elementary school level. The question remains whether districts will offer professional development courses to elementary school teachers so that they may incorporate STEM further in their classrooms. Further knowledge and understanding of STEM at an elementary school level will allow teachers to better embrace and teach STEM concepts. This need is clearly shown and voiced by the principals surveyed.

Research Question 2: Are administrators requiring teachers to pursue STEM training? The findings showed 73.61 percent of principals showed moderate, low, and very low support for STEM related training for their teachers within the last two years. A principal's level of requirement for teachers to pursue STEM related training was low with a mean of 2.29. This indicates that principals do not have a high requirement for teachers to pursue STEM related training.

Both these findings could be a result of a low knowledge level of STEM related concepts or lack of available training. Some districts may not be providing STEM related training that is applicable at an elementary school level. Elementary school teachers that have not received training on STEM curricula may struggle to carryout concepts they have not been trained to implement or initiate.

Research Question 3: Are administrators currently implementing STEM education initiatives in their school? The researcher found a low level of STEM implementation with 52.06 percent of principals ranking their implementation level low or very low. Administrators ranked their level of requirement for teachers to implement STEM related activities as low with a mean of 2.31. The time teachers spent on STEM related activities weekly was 0% to 25% of time with 47 of 71 principals (66.20%) stating this fact. Moreover, one of 71 principals stated that their teachers spent more than 75 percent of the time implementing STEM related activities. This indicates that there is a small amount of time spent by teachers in elementary schools implementing STEM related lessons and activities. STEM training is vital to increase teacher awareness and support for STEM initiatives. If elementary educators are to increase time spent on STEM related activities, then training on STEM concepts is imperative. After teachers receive STEM training, principals can then require more time within the week to carryout STEM lessons in their teacher's classrooms.

Research Question 4: What STEM education related training do administrators believe could be implemented in their districts within the next five years? This research question showed positive results. Seventy percent of

principals who responded believed STEM related training should be integrated in their schools within the next five years. In survey Question 9, the researcher asked principals to choose the most important initiatives to further STEM in elementary schools. Professional development was shown to be the most important initiative with 37.42% and STEM integration and implementation strategies followed closely with 34.84%. When asked in survey Question 10, what changes needed to occur to further incorporate STEM concepts in their schools, respondents again stressed the need for professional development with 44.26% commenting on the importance of receiving further professional development on this concept.

The survey responses clearly showed professional development is crucial in achieving STEM proficiency in elementary schools. While STEM integration was also shown as important, elementary school principals voiced concern that their teachers were dependant on the training offered and supported by their districts. If there was no support or training offered at the district level, elementary school administrators were unable or unwilling to support STEM related training for their teachers. Based on interpretation of the survey responses, the researcher determined that the following items needed to occur for public elementary schools to implement STEM related concepts:

- Increase STEM professional development opportunities for elementary school teachers and principals,
- Increase awareness of STEM,

- Increase support for STEM training at a district level so all levels of teachers can receive STEM related training,
- Align state and local standards to so STEM concepts can be easily integrated,
- Provide funding resources and budgeting leeway for STEM training and integration in classrooms to include materials needed for lessons,
- Improve technology to meet the current level of needs of students
- Allow for time to be spent on STEM related lessons, and
- Develop partnerships within the community to assist in STEM implementation and activities.

Given the responses by elementary school principals, the researcher concluded that a majority of principals agreed that STEM should be implemented in their districts and schools. This study revealed an essential need for professional development for elementary school personnel on STEM related concepts. The study revealed a low knowledge level of STEM. However, principals did state that their districts were beginning to provide some STEM related training, but not enough at an elementary school level. Overall, the study collected quality data to answer each of four research questions; nonetheless, further research is needed.

RECOMMENDATIONS

This study was performed to determine if public elementary schools have received STEM education related training that could be integrated into current

instruction at this level. The data indicated that most elementary schools had not received adequate training on STEM related concepts. Based on the results and conclusions of this study, the following recommendations were made:

- Quality, on-going STEM professional development that is applicable to elementary school personnel and aligns with current standards is needed for elementary schools to reach STEM proficiency
- Adequate time allotment by the districts/schools for teachers must be allowed for STEM lessons to be taught and for professional development to be pursued.
- Administrators should endorse and require a high-level of time commitment to STEM related lessons as the benefit to students is greatly increased when taught correctly and not rushed.
- Integration and implementation strategies for STEM activities must be actively taught and shared so that teachers can implement STEM effectively. These strategies must be maintained, changed, and new strategies should be developed so teachers can maintain their level of enthusiasm for the lessons they are going to teach.
- Proper materials must be supplied for any STEM activities so that both the teachers and students can benefit from the activities that are being implemented.

Based on the findings and conclusions of this study, the researcher recommends the following for future studies:

- This study should be modified to compare responses about STEM related training in elementary schools from various states or regions.
- A study may be conducted to compare the level of STEM mastery for students receiving STEM education in elementary schools versus those students receiving STEM education only in high school.
- A study may be conducted to determine what STEM related training is most successful for elementary school personnel in achieving STEM proficient learners.
- A study may also be conducted to determine the development and advertisement of a re-certification course in Elementary School STEM Instructional Strategies.

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APPENDIX A

List of Elementary Schools

District	Elementary School	City
Charles City	Charles City Elementary School	Charles City
Chesterfield	Bellwood Elementary School	Richmond
Chesterfield	Bensley Elementary School	Richmond
Chesterfield	Beulah Elementary School	Richmond
Chesterfield	Bon Air Elementary School	Bon Air
Chesterfield	Chalkley Elementary School	Chesterfield
Chesterfield	Clover Hill Elementary School	Midlothian
Chesterfield	Crenshaw Elementary School	Midlothian
Chesterfield	Crestwood Elementary School	Richmond
Chesterfield	Curtis Elementary School	Chester
Chesterfield	Davis Elementary School	Richmond
Chesterfield	Ecoff Elementary School	Chester
Chesterfield	Enon Elementary School	Chester
Chesterfield	Etterick Elementary School	Ettrick
Chesterfield	Evergreen Elementary School	Midlothian
Chesterfield	Falling Creek Elementary School	Richmond
Chesterfield	Gates Elementary School	Chesterfield
Chesterfield	Gordon Elementary School	Richmond
Chesterfield	Grange Hall Elementary School	Mosley

List of Elementary Schools cont.

District	Elementary School	City
Chesterfield	Green Field Elementary School	Richmond
Chesterfield	Harrogate Elementary School	Chester
Chesterfield	Hening Elementary School	Richmond
Chesterfield	Hopkins Elementary School	Richmond
Chesterfield	Jacobs Road Elementary School	Chesterfield
Chesterfield	Marguerite Christian Elementary School	Colonial Heights
Chesterfield	Matoaca Elementary School	Matoaca
Chesterfield	Providence Elementary School	Richmond
Chesterfield	Reams Road Elementary School	Richmond
Chesterfield	Robius Elementary School	Midlothian
Chesterfield	Salem Church Elementary School	Richmond
Chesterfield	Elizabeth Scott Elementary School	Chester
Chesterfield	Alberta Smith Elementary School	Midlothian
Chesterfield	Spring Run Elementary Schools	Midlothian
Chesterfield	Swift Creek Elementary Schools	Midlothian
Chesterfield	Watkins Elementary School	Midlothian
Chesterfield	Weaver Elementary School	Midlothian
Chesterfield	Wells Elementary School	Chester
Chesterfield	Winterpock Elementary School	Chesterfield
Chesterfield	Woolridge Elementary School	Midlothian
Colonial Heights	Lakeview Elementary School	Colonial Heights

List of Elementary Schools cont.

District	Elementary School	City
Colonial Heights	North Elementary School	Colonial Heights
Colonial Heights	Tussing Elementary School	Colonial Heights
Dinwiddie	Dinwiddie Elementary Schools	Dinwiddie
Dinwiddie	Sutherland Elementary	Sutherland
Dinwiddie	Midway Elementary	Church Road
Dinwiddie	Southside Elementary School	Dinwiddie
Dinwiddie	Sunnyside Elementary School	McKenney
Goochland	Byrd Elementary School	Goochland
Goochland	Goochland Elementary School	Goochland
Goochland	Randolph Elementary School	Crozier
Hanover	Battlefield Park Elementary School	Mechanicsville
Hanover	Beaver Dam Elementary School	Beaverdam
Hanover	Cold Harbor Elementary School	Mechanicsville
Hanover	Cool Spring Elementary School	Mechanicsville
Hanover	Elmont Elementary School	Ashland
Hanover	Henry Clay Elementary School	Ashland
Hanover	John M. Gandy Elementary School	Ashland
Hanover	Kersey Creek Elementary	Mechanicsville
Hanover	Laurel Meadow Elementary School	Mechanicsville
Hanover	Mechanicsville Elementary School	Mechanicsville
Hanover	Pearson's Corner Elementary School	Mechanicsville

List of Elementary Schools cont.

District	Elementary School	City
Hanover	Pole Green Elementary School	Mechanicsville
Hanover	Rural Point Elementary School	Mechanicsville
Hanover	South Anna Elementary School	Montpellier
Hanover	Washington-Henry Elementary School	Mechanicsville
Henrico	Adams Elementary School	Henrico
Henrico	Ashe Elementary School	Henrico
Henrico	Baker Elementary School	Henrico
Henrico	Carver Elementary School	Henrico
Henrico	Chamberlayne Elementary School	Henrico
Henrico	Colonial Trail Elementary School	Glen Allen
Henrico	Crestview Elementary School	Henrico
Henrico	Davis Elementary School	Henrico
Henrico	Donahoe Elementary School	Sandston
Henrico	Dumbarton Elementary School	Henrico
Henrico	Echo Lake Elementary School	Glen Allen
Henrico	Fair Oaks Elementary School	Highland Springs
Henrico	Gayton Elementary School	Henrico
Henrico	Glen Allen Elementary School	Glen Allen
Henrico	Glen Lea Elementary School	Henrico
Henrico	Greenwood Elementary School	Glen Allen
Henrico	Harvie Elementary School	Henrico

List of Elementary Schools cont.

District	Elementary School	City
Henrico	Highland Springs Elementary School	Highland Springs
Henrico	Holladay Elementary School	Henrico
Henrico	Johnson Elementary School	Henrico
Henrico	Laburnam Elementary School	Henrico
Henrico	Lakeside Elementary School	Henrico
Henrico	Longan Elementary School	Henrico
Henrico	Longdale Elementary School	Glen Allen
Henrico	Maybeury Elementary School	Henrico
Henrico	Mehfoud Elementary School	Henrico
Henrico	Montrose Elementary School	Henrico
Henrico	Nuckols Farm Elementary School	Henrico
Henrico	Pemberton Elementary School	Henrico
Henrico	Pinchbeck Elementary School	Henrico
Henrico	Ratcliffe Elementary School	Henrico
Henrico	Ridge Elementary School	Henrico
Henrico	Rivers Edge Elementary School	Glen Allen
Henrico	Sandston Elementary School	Sandston
Henrico	Seven Pines Elementary School	Sandston
Henrico	Shady Grove Elementary School	Glen Allen
Henrico	Short Pump Elementary School	Henrico
Henrico	Skipwith Elementary School	Henrico

List of Elementary Schools cont.

District	Elementary School	City
Henrico	Springfield Park Elementary School	Glen Allen
Henrico	Three Chopt Elementary School	Henrico
Henrico	Trewett Elementary School	Henrico
Henrico	Tuckahoe Elementary School	Henrico
Henrico	Twin Hickory Elementary School	Glen Allen
Henrico	Varina Elementary School	Henrico
Henrico	Ward Elementary School	Henrico
Hopewell	Dupont Elementary School	Hopewell
Hopewell	Harry E. James Elementary School	Hopewell
Hopewell	Patrick Copeland Elementary School	Hopewell
New Kent	New Kent Elementary School	New Kent
New Kent	George W. Watkins Elementary School	Quinton
Nottoway	Burkeville Elementary School	Burkville
Nottoway	Blackstone Primary School	Blackstone
Powhatan	Powhatan Elementary School	Powhatan
Powhatan	Pocahontas Elementary School	Powhatan
Powhatan	Flat Rock Elementary School	Powhatan
Petersburg	A.P. Hill Elementary School	Petersburg
Petersburg	J.E.B Stuart Elementary School	Petersburg
Petersburg	Robert E. Lee Elementary School	Petersburg
Petersburg	Walnut Hill Elementary School	Petersburg

List of Elementary Schools cont.

District	Elementary School	City
Prince George	North Elementary School	Prince George
Prince George	South Elementary School	Disputana
Prince George	Harrison Elementary School	Disputana
Prince George	Walton Elementary	Prince George
Prince George	Beazley Elementary School	Prince George
Richmond	Bellevue Elementary School	Richmond
Richmond	Blackwell Elementary School	Richmond
Richmond	Broad Rock Elementary School	Richmond
Richmond	Carver Elementary School	Richmond
Richmond	John B. Cary Elementary School	Richmond
Richmond	Chimborazo Elementary School	Richmond
Richmond	Clark Springs Elementary School	Richmond
Richmond	Fairfield Court Elementary School	Richmond
Richmond	Fisher Elementary School	Richmond
Richmond	William Fox Elementary School	Richmond
Richmond	J.L. Francis Elementary School	Richmond
Richmond	Ginter Park Elementary School	Richmond
Richmond	E.S.H. Greene Elementary School	Richmond
Richmond	Linwood Holton Elementary School	Richmond
Richmond	M.J. Jones Elementary School	Richmond
Richmond	George Mason Elementary School	Richmond

List of Elementary Schools cont.

District	Elementary School	City
Richmond	Mary Munford Elementary School	Richmond
Richmond	Oak Grove Elementary School	Richmond
Richmond	Overby-Sheppard Elementary School	Richmond
Richmond	E.D. Redd Elementary School	Richmond
Richmond	G.H. Reid Elementary School	Richmond
Richmond	Southampton Elementary School	Richmond
Richmond	J.E.B. Stuart Elementary School	Richmond
Richmond	Summer Hill Elementary School	Richmond
Richmond	Swansboro Elementary School	Richmond
Richmond	Westover Hills Elementary School	Richmond
Richmond	Woodville Elementary School	Richmond
Surry	Surry Elementary School	Dendron
Sussex	Ellen Warren Chambliss Elementary School	Wakefield
Sussex	Jefferson Elementary School	Jarratt

Note. Elementary Schools, N=159

APPENDIX B

Survey Instrument

(*STEM Training and Integration for Elementary School Personnel*)

OLD DOMINION UNIVERSITY *STEM Training & Integration for Elementary School Personnel*

The purpose of this questionnaire is to gather feedback from elementary school administrators in regards to STEM related training and integration. **STEM**, defined as **S**cience, **T**echnology, **E**ngineering, and **M**athematics, integrates the four disciplines and transforms a typical teacher-centered classroom by encouraging curriculum that is driven by problem-based learning, exploratory learning and discovery, and requires students to actively engage in an age-appropriate problem in order to find its solution. In cooperation with Old Dominion University, the researchers will hold all responses in strict confidence during this study. Information you provide will be statistically summarized with other responses and will not be attributable to any single individual. Participation is voluntary and your completion of this survey indicates your willingness to participate in this study. The information you provide is greatly appreciated. Thank you for taking the time to assist in this research.

Directions: Please darken the circle that indicates your selection or write-in your answer as appropriate. Some questionnaire items include an area to provide further comment.

1. How would you rate **your knowledge** of STEM education and its implementation?

   ○ Very low ○ Low ○ Moderate ○ High ○ Very high

2. Is the concept of STEM **influencing** professional development and training programs in your school?

   ○ Very low ○ Low ○ Moderate ○ High ○ Very high

   Comment:_____

   _____

3. To what degree have you endorsed **STEM training or STEM professional development for your teachers** in the last two years that could be implemented into your school?

   ○ Very low ○ Low ○ Moderate ○ High ○ Very high

   Comment:_____

   _____

4. What **level of requirement** do your teachers have in pursuing STEM related training?

   ○ Very low ○ Low ○ Moderate ○ High ○ Very high

   Comment:_____

   _____

5. How would you rate your school's **current implementation of STEM integrative concepts** and activities?

   ○ Very low ○ Low ○ Moderate ○ High ○ Very high

6. As an administrator, how much time **do you require classroom teachers to currently implement** STEM initiatives in their classroom?

○ Very low ○ Low ○ Moderate ○ High ○ Very high

Comment:_____

_____

7. What percentage of time would you estimate that your classroom teachers devote to **implementing STEM initiatives or activities** in their classroom per week?

○ 0% of the time
○ 0%-25% of the time
○ 25%-50% of the time
○ 50%-75% of the time
○ Over 75% of the time

Comment:_____

_____

8. To what degree do you believe that **STEM related training** should be **integrated in your school within the next five years**?

○ Very low ○ Low ○ Moderate ○ High ○ Very high

Please list any specific STEM or Engineering programs you or your teachers have participated in:_____

_____

9. Of the options listed below, which STEM initiatives are **most important for your school in the next five years?**

____ STEM Integration & Implementation Strategies
____ STEM Curriculum
____ STEM Professional Development
____ STEM Community/Institution Partnerships

Comment:_____

_____

10. What changes need to occur to **effectively incorporate STEM concepts** into your elementary school in the next five years?

    Responses:

    _____

    _____

    _____

    _____

    This concludes the questionnaire. Thank you again for your participation in this survey.

Name: _____ School: _____

APPENDIX C
Sample Cover Letter

April 16, 2011

<<Title>> <<Firstname>> <<Lastname>>
<<Elementary School>>
<<Address1>>
<<Address2>>
<<City>>, <<State>> <<Zip>>

Dear <<Greeting Line>>

In 2009, President Obama set an ambitious goal to move U.S. students from the middle to the top of the pack in math and science achievement over the next decade. Steven C. Beering, former Chairman of the National Science Board, stated, "Our national economic prosperity and security require that we remain a world leader in science and technology." **STEM**, defined as **S**cience, **T**echnology, **E**ngineering, and **M**athematics, integrates these four disciplines and transforms a typical teacher-centered classroom by encouraging a curriculum that is driven by problem-based learning, exploratory learning and discovery, and requires students to actively engage a problem in order to find its solution. In the State of the Union, President Obama has called for a renewed effort to prepare 100,000 science, technology, engineering, and math (STEM) teachers with strong teaching skills and deep content knowledge over the next decade. The purpose of our research study is to determine what elementary school administrator's or their teacher's current level of STEM training and integration is to help students become STEM proficient in our global economy.

Enclosed you will find a questionnaire and a postage-paid return envelope. Participation in this study is voluntary, however, your assistance and expertise will add to the current body of research on STEM related training and integration at an elementary school level. The information you provide will be kept under strict confidentiality and reported only in aggregate form. A high response rate is imperative to this research, so we encourage you to please respond. Your completion and return of this survey indicates that you've been informed of the purpose of the study and your role, and that you consent to participate and allow us to use your responses in our study.

As an incentive for your time and completed questionnaire, you will be entered into a drawing for one of two $50.00 Visa gift cards. We know your time is valuable and your efforts are appreciated. Completing the questionnaire should require about 10 minutes of your time. Winners will be notified via mail by <<Date>>>. Please feel free to contact us should you have any questions or comments. All survey data will be held in strict confidence by the researchers. Please return the questionnaire in the postage-paid envelope by <<Date>>. Thank you in advance for your cooperation and support of this research study.

Sincerely,

Dr. John M. Ritz, DTE
Professor, Department of STEM Education
Old Dominion University

Diana V. Cantu
ODU Graduate Student
dcant005@odu.eu\du