2011

Methods Used to Integrate STEM Subjects into K-12 Technology Education Classrooms

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This Research Paper Was Submitted to the Graduate Faculty of the Department of STEM Education and Professional Studies at Old Dominion University

In Partial Fulfillment of the
Requirement for the Degree
Masters of Science in STEM Education and Professional Studies
Community College Teaching Concentration

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August 2011

SIGNATURE PAGE

Matt Basilone prepared this 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 STEM Education and Professional Studies.

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Introduction

Technology education is in a transitional period. Technology is becoming an increasingly important, integrated part of our world. Technology education has experienced some changes, allowing computers and automation to become a larger focus of the curriculum. However, the greater integration of technology in our world is yet to experience reflection in what is taught to our technology students.

The most recent push in technology education is to broaden the subject matter to include science, mathematics and engineering along with technology content. This integration is far from superficial.

> Traditionally, school curriculum has been largely based on the concept that instruction should be separated into distinct subjects for ease of understanding and then reassembled when complex applications are required. It is assumed that students readily re-connect their school knowledge and then use it in an applied context outside of the classroom. Here in lies the crux of the matter, the school curricula is a segregated approach to instructional topics which does not adequately address the reassemblage of topics into a coherent body of knowledge to be used by students. (Wicklein & Schell, 1995, p. 59)

President Obama has recognized the need for improvement in our educational system for the four STEM subjects:

> Students need to be able to solve problems, apply appropriate technologies, and design solutions – skills honed by science, technology, engineering, and mathematics (STEM) education. We have seen other nations eclipse ours in preparing their children in these critical fields. To enable our students to thrive, schools need effective STEM educators. These programs will be developed in conjunction with a government-wide effort to improve the impact of Federal investments in math and science education by ensuring that all programs supporting K-12 and undergraduate education adhere to consistent standards of effectiveness. (Winning the Future, 2011, p. 1)

The STEM subjects are very important for the future of our country. The United States is falling behind in these areas and the leaders of the country's educational system need to provide teachers with better strategies for conveying these subjects.

Statement of the Problem

The problem of this study was to determine technology education teachers' use of methods to integrate science, technology, engineering and mathematics into technology education courses for improved student learning of complex ideas.

Research Goals

The goals of this study were to answer the following questions:

RQ_1: Are there common practices used by technology education teachers to integrate the STEM subjects into technology education courses?

RQ_2: How is the integrated technology classroom perceived by administrators?

RQ_3: Do technology teachers feel that STEM subject integration takes away from time spent on achieving technological literacy standards?

Background and Significance

Technology education was once taught as technical education, training for physical laborers and not much more. As technology has grown in prominence and complexity, the school subject of technology education has the opportunity to move into a more prominent role in schools, possibly right next to the other core courses. Due to budget constraints, this will not happen easily. A possible catalyst for this move is the integration of the STEM subjects and federal initiatives.

STEM originated in the early 1990s at the National Science Foundation (Bybee, 2010). In the past technology education courses have provided less to the college bound student and have been aimed to help students immediately entering the work force. The world is changing and occupations requiring technological literacy are growing in number and significance. This study arose as the landscape of technology education has changed.

This study will allow technology educators to better serve the changing needs of technology students. The Bureau of Labor and Statistics projects that the largest sector of occupational growth from 2002 to 2012 will be computer and mathematics (Bls Releases 2002-12, 2004). This increase in jobs will require an increase in work force, thus an increase in training and education in these fields. The occupations related to the STEM fields are often interrelated.

Limitations

The boundaries of this study are:

- Some teachers of technology education courses might not integrate the STEM subjects through their teaching.
- The practices in use by teachers of technology courses might not be easily explained.
- Perception of the integration by those involved might not be significant.
- The time spent on technology education standards could be more important than time on other STEM subjects in some regions.
- The sample is of exemplary teachers; Technology Education Teacher of the Year awardees, but still a small sample compared to the entire population of technology education teachers.
- The study will be but a snap shot of current practices for what might be a very young concept in practice.

Assumptions

Under the circumstances of this study:

- Integration of STEM subjects is a positive progression of technology education courses.
- The positive progression of STEM integration is a shared view of the country's education systems.

- The teachers polled have planned, used, and evaluated the strategies for STEM integration that they report.

Procedures

In order to complete this study, the researcher created an survey to collect strategies in use for integrating STEM subjects through technology education courses. The researcher mailed the survey to Technology Education Teacher of the Year award winners. Upon receipt of the completed surveys, the researcher compiled and studied the data, looking for significant indicators of common practices. Those results were then reported and conclusions and recommendations were made.

Definition of Terms

The following terms are important or unique to this study.

STEM- Science, technology, engineering and mathematics, the subjects which are to be integrated.

Technology Education Teacher of the Year award winners- Teachers that have been recognized for their efforts teaching technology courses at the elementary, middle, or high school levels.

Technology education course with integrated STEM concepts- any technology education course that also incorporates aspects from the science, engineering, and mathematics fields.

Overview of Chapters

STEM education is currently fragmented when coursework is presented to students. STEM occupations are growing more rapidly than other occupations.

These occupations are not in a single STEM field, but require knowledge in multiple STEM areas. This integrated version of STEM needs to find its way into STEM courses. Current successful technology education teachers are using strategies to integrate these subjects. This study will report on these strategies as well as the implications of the integration.

The review of literature was completed in order for the researcher to have an informed foundation to build the results of the study. The literature points to the importance and benefit of STEM integration in technology courses.

The methods to complete the study were as follows. The survey was constructed and sent to the sample of teachers. Upon receiving the completed survey, the researcher studied the data from the survey and tabulated the information in order to make conclusions and recommendations.

The findings were written to compile the data from the survey. The data pointed to common practices utilized to integrate the STEM subjects in technology courses.

The findings led the researcher to make the following conclusions and recommendations. STEM integration is a positive progression for technology education. The strategies put into practice by the Technology Education Teachers of the Year award winners to integrate the STEM subjects are sound strategies that successfully mimic the way students will encounter the subjects upon entering the work force or farther down their academic paths.

Chapter II

Review of Literature

Review of the following literature is presented to support the need for and effectiveness of strategies that integrate the STEM subjects in technology education courses. STEM education has been identified as a focal point of reform and importance in order to better serve students in the immediate future. STEM gives students the opportunity to initiate and continue development of 21st Century skills. These skills can include adaptability, complex communication, social skills, non-routine problem solving, self-management, self development, and systems thinking (NRC, 2010). STEM courses, like other courses have often been taught independent of one another with technology being an elective and engineering receiving very little attention. An integrated approach would cover the subjects more evenly and better mimic the way that students will interact with these subjects later in life. While reform is sometimes preached, there are teachers using integrative strategies successfully in STEM courses currently. In this study, the strategies used to integrate the STEM subjects are investigated.

President’s Call to Action

With focus on K-12 education, President Obama tasked his Council of Advisers on Science and Technology to recommend ways for the United States to improve STEM education (K-12 Science, 2011). The report included two conclusions: “To improve STEM education, we must focus on both preparation and inspiration,” and “The federal government has historically lacked a coherent strategy and sufficient leadership capacity for K-12 STEM education" (K-12 Science, 2011). In addition to the two conclusions are seven recommendations:

1. Support the current state-led movement for shared standards in math and science.
2. Recruit and train 100,000 great STEM teachers over the next decade who are able to prepare and inspire students.
3. Recognize and reward the top 5% of the nation's STEM teachers by creating a STEM Master Teachers Corps.
4. Use technology to drive innovation, by creating an advanced research projects agency for education.
5. Create opportunities for inspiration through individual and group experiences outside the classroom.
6. Create 1,000 new STEM-focused schools over the next decade.
7. Ensure strong and strategic national leadership. (K-12 Science, 2011)

The President and the federal government have identified the STEM subjects as an area of need. This concept and the ideas for improvement in this report are neither unique nor new.

The STEM Subjects

In a 2010 article by Todd Kelley, *Staking the Claim for the 'T' in STEM*, the back story of STEM subject integration is described. In the early 1990s, an initiative to improve the country's science and math scores called the Math, Science and Technology movement. The goals of this movement were quite similar to the recommendations made by the President's Council. The Math, Science and Technology movement was a strong initiative with clearly identified needs. However, research by Daugherty and Wicklein (1993), cited by Kelley, a negative perception of technology education was encountered.

Kelley (2010) does not discount the efforts of the MST movement, but claims, "no previous multidisciplinary and interdisciplinary efforts in technology education's history has such potential to impact the field greater than the recent Science, Technology, Engineering, and Mathematics (STEM) movement.

In the conclusions of a 2010 study, the use of subjects and skills in the field of engineering is analyzed,

> Practicing engineers present a more nuanced picture of the relationship between mathematics knowledge and engineering practice. [The] engineers placed problem solving and mathematics within a rich array of considerations. For example, communication skills rather than mathematics or science knowledge were the most highly reported of the "essential skills", followed by using resources to solve problems. In their explanations, engineers framed their work more broadly: "Engineering is not about numbers and formulas. Engineering is more about interacting with your customers." "It was an amazing blend of teamwork, urgency, logical planning, analysis and testing, often with ethical consequences." "It required creativity, subject matter knowledge, good experimental skills,

> communication, interdisciplinary cooperation, and a whole lot of persistence" (Nathan et al., 2010, pp. 420-421).

In a later conclusion, the authors look at the integration of the STEM subjects in the classroom.

> Central to the current reform movement in engineering education is the acknowledgment of the need to go beyond technical education on the one hand and academic preparation on the other. The knowledge and skills offered by each needs to be integrated in order to promote effective engineering practices. This need is clearly evident in several significant initiatives, such as the reauthorization of the Perkins Career and Technical Education Improvement Act of 2006, which mandated the integration of technical education with mathematics and science so that "students achieve both academic and occupational competencies"; the increased attention on STEM education as an integrated program in science, technology, engineering, and mathematics; and recent policy initiatives such as the U.S. Department of Education "Race to the Top" Program. (Nathan et al., 2010, p. 421)

The authors are focused on the engineering field, but point out the importance of integrating the STEM subjects and problem solving for students learning to become part of the work force.

This concept of integration is emphasized by many. In an article from 2010, *Advancing the "E" in K-12 STEM Education* (Rockland et al., 2010, pp. 53-55), the authors are also focused on engineering education. "In K-12 schools the focus has unfortunately been on the topic "engineering design" at the neglect of engineering principles and processes with hands-on applications" (Rockland et al., 2010, p. 60). The authors use a report from 2009 on integrating engineering into curriculums to emphasize this stance. "[It] ask students to make use of math, science, and technology knowledge and skills…and emphasize problem solving, the ability to use equipment and technology, communication and collaboration with others" (Cavanaugh, 2009). There are many more factors playing a part in the education of students for the occupational world than the individual subjects of science, technology, and mathematics.

Sanders (2009) explores *STEM, STEM education, STEMmania.* Obviously, he has separated the ideas. STEM is "…a reference to the fields in which scientists, engineers, and mathematicians toil" (p. 20). STEM education, which he claims the education is often omitted, is learning about those fields with the consideration of technological literacy as well. STEMmania is the recent craze associated with the need for the United States to improve test scores and performance in the STEM subjects. He specifically describes integrative STEM education by stating:

> Our notion of integrative STEM education includes approaches that explore teaching and learning between/among any two or more of the

> STEM subject areas, and/or between a STEM subject and one or more other school subjects. Just as technological endeavor, for example, cannot be separated from social and aesthetic contexts, neither should the study of technology be disconnected from the study of the social studies, arts, and humanities. (Sanders, 2009, p. 21)

Sanders then describes a specific manor in which technology and science education can be integrated:

> A pedagogy we refer to as “purposeful design and inquiry” (PD&I) is a seminal component of integrative STEM education. PD&I pedagogy purposefully combines technological design with scientific inquiry, engaging students or teams of students in scientific inquiry situated in the context of technological problem-solving-a robust learning environment. Over the past two decades of educational reform, technology education has focused on technological design, while science education has focused on inquiry. Following the PD&I approach, students envisioning and developing solutions to a design challenge might, for example, wish to test their ideas about various materials and designs, or the impact of external factors upon those materials and designs. In that way, authentic inquiry is embedded in the design challenge. This is problem-based learning that purposefully situates scientific inquiry and the application of mathematics in the context of technological designing/problem solving. Inquiry of that sort rarely occurs in a technology education lab, and technological design

> rarely occurs in the science classroom. But in the world outside of schools, design and scientific inquiry are routinely employed concurrently in the engineering of solutions to real-world problems.
>
> Many technology teachers are fond of saying they teach science and math in their technology education programs. In truth, it is exceedingly rare for a technology teacher to explicitly identify a specific science or mathematics concept or process as a desired learning outcome and even rarer for technology teachers to assess a science or mathematics learning outcome. Technology education students might very well do some arithmetic or recognize a scientific principle at play in route to completing a design challenge, but those design challenges are almost never conceived to purposefully teach a desired science or mathematics learning outcome. Thought of in this way, the notion of "purposeful design and inquiry" represents a new frontier in education - a frontier toward which integrative STEM education research and practice are targeted.
> (Sanders, 2009, p. 21)

Sanders places emphasis on a couple of key elements for effective STEM integration.

Summary

This chapter served as a review of the literature describing the problem of this study. The literature identifies need for improvement in STEM education that the federal government is behind. The needs for improvement include the areas of strategy and method of instruction. The literature points to advocates for an integrated problem based approach, but this support is young. STEM education is growing out of the standard, individualized subject approach and into an integrated education approach. Just as the support is young, so is the act of integration itself. For a successful method, the objectives of the integrated subjects must be intended, stated and assessed.

Chapter III

Methods and Procedures

The following chapter presents the research methods and procedures used in this study. It consists of the research population, the survey for collection of data, the method for collection of data, and the analysis of data.

Population

The population of this study was the 35 2011 ITEEA Technology and Engineering Teacher Excellence Award winners. These teachers are recognized for outstanding performance in their field. Specifically, the ITEEA describes the award as:

> The Teacher Excellence Award is the most prestigious award given in recognition of Technology and Engineering Education Teachers. The awards are presented to elementary, middle and high school teachers who are honored at this session. (ITEEA Technology & Engineering Teacher Excellence Awards Pamphlet, 2011)

Instrument Design

The survey designed to gather data from the population was a closed-form, Likert-scale survey combined with an open form survey. The closed-form, Likert-scale questions were used to determine the frequency with which the population teaches the STEM subjects in their technology education courses, the support the population receives for integrating the STEM subjects in their technology education courses, and the amount the population is asked to integrate the STEM subjects in their technology education courses. This section also gauged how well these integrative methods aid students to succeed in their technology education courses and develop higher order thinking skills. The open-form questions asked for specific methods or lessons they integrated the STEM subjects. This section of the survey allowed teachers to share methods and lesson they feel are successful. These questions were developed in order to answer the research questions, raised by the review of literature. See Appendix A.

Methods of Collection

The survey was mailed to the 35 teachers of the year with a cover letter on May 27, 2011. Included was a stamped, return addressed envelope for the subject to return the survey. See Appendix B.

Statistical Analysis

The data collected from the close-form survey were analyzed using the mean of responses for each question. This gave a depiction of the average response of the sample population.

The information gathered from the open-form part of the survey was used to provide specific examples of STEM integration. These examples, along with the data from the close-form component of the survey, were used in the recommendations section.

Summary

The survey for this study was designed to gather information about the integration of STEM subjects in technology education courses. This survey was sent to 35 ITEEA teachers of the year throughout the United States to represent the best in the field. The surveys were then collected and analyzed in order to reach conclusions and make recommendations about methods to integrate the STEM subjects in technology education courses.

Chapter IV

Findings

This chapter was a report of the findings of the survey, which was designed to determine technology education teachers' use of methods to integrate science, technology, engineering, and mathematics into technology education courses. The findings were separated into two sections. The first was a tabulation and statistical analysis of the 12 Likert-scaled questions and the second was a synopsis of the responses to the open response questions. The problem of this study was to determine technology education teachers' use of methods to integrate science, technology, engineering, and mathematics into technology education courses for improved student learning of complex ideas.

Response Rate

The survey was mailed to 35 recipients of the International Technology and Engineering Educators Association 2011 Technology and Engineering Teacher Excellence Award on May 27, 2011. Due to a low number of initial responses, follow-up correspondence was sent via electronic mail and then by phone call. The data collection was completed between May 27, 2011 and August 2, 2011. Sixty percent of the population responded, which was 21 of the 35 award winners.

Data Analysis

For the closed form, Likert-scale questions, 12 statements allowed the responders to choose one response. The Likert-scale allowed responders to choose Strongly Agree (value of 5), Agree (4), Undecided (3), Disagree (2) or Strongly Disagree(1).

Item 1 stated “It is important to integrate science, engineering, and mathematics into technology education courses in order for students to develop higher order thinking skills and understand complex subjects.” Eighteen of 21 strongly agreed with this statement (86%). Three of 21 agreed with this statement (14%). The mean of the response values for this question was 4.86, indicating that technology education teachers strongly agree with this statement.

Question 2 stated “You often integrate national or state **technology** standards in your technology education lessons.” Seventeen of 21 strongly agreed with this statement (81%). Four of 21 agreed with this statement (19%). The mean of the response values for this question was 4.81, indicating that technology education teachers strongly agree with this statement.

Question 3 stated “You often integrate national or state **science** standards in your technology education lessons.” Thirteen of 21 strongly agreed with this statement (62%). Seven of 21 agreed with this statement (33%). One of 21 disagreed with this statement (5%). The mean of the response values for this question was 4.43, indicating that technology education teachers agree with this statement.

Question 4 stated “You often integrate national or state **engineering** standards in your technology education lessons.” Thirteen of 21 strongly agreed with this statement (65%). Four of 21 agreed with this statement (20%). Two of 21 were undecided with this statement (10%). One of 21 disagreed with this statement (5%). The mean of the response values for this question was 4.45, indicating that technology education teachers agree with this statement. *One teacher did not respond to this question, so the value of n was decreased to 20 in order to preserve the mean value.

Question 5 stated “You often integrate national or state **mathematics** standards in your technology education lessons.” Eleven of 21 strongly agreed with this statement (52%). Eight of 21 agreed with this statement (38%). Two of 21 disagreed with this statement (10%). The mean of the response values for this question was 4.33, indicating that technology education teachers agree with this statement.

Question 6 stated “You are **asked** to integrate national or state **science** standards in your technology education lessons.” Five of 21 strongly agreed with this statement (24%). Eight of 21 agreed with this statement (38%). Two of 21 were undecided with this statement (10%). Six of 21 disagreed with this statement (29%). The mean of the response values for this question was 3.57, indicating that technology education teachers agree with this statement.

Question 7 stated “You are **asked** to integrate national or state **engineering** standards in your technology education lessons.” Six of 21 strongly agreed with this statement (29%). Three of 21 agreed with this statement (14%). Eight of 21 were undecided with this statement (38%). Four of 21 disagreed with this statement (19%). The mean of the response values for this question was 3.52, indicating that technology education teachers agree with this statement.

Question 8 stated “You are **asked** to integrate national or state **mathematics** standards in your technology education lessons.” Six of 21 strongly agreed with this statement (29%). Six of 21 agreed with this statement (29%). Three of 21 were undecided with this statement (14%). Six of 21 disagreed with this statement (29%). The mean of the response values for this question was 3.57, indicating that technology education teachers agree with this statement.

Question 9 stated “You get **support** from administration/supervision to integrate national or state **science** standards in your technology education lessons.” Eleven of 21 strongly agreed with this statement (52%). Two of 21 agreed with this statement (10%). Six of 21 were undecided with this statement (29%). One of 21 disagreed with this statement (5%). One of 21 strongly disagreed with this statement (5%). The mean of the response values for this question was 4.00, indicating that technology education teachers agree with this statement.

Question 10 stated “You get **support** from administration/supervision to integrate national or state **engineering** standards in your technology education lessons.” Twelve of 21 strongly agreed with this statement (57%). Two of 21 agreed with this statement (10%). Four of 21 were undecided with this statement (19%). Three of 21 disagreed with this statement (14%). The mean of the response values for this question was 4.10, indicating that technology education teachers agree with this statement.

Question 11 stated "You get **support** from administration/supervision to integrate national or state **mathematics** standards in your technology education lessons." Twelve of 21 strongly agreed with this statement (57%). One of 21 agreed with this statement (5%). Four of 21 were undecided with this statement (19%). Four of 21 disagreed with this statement (19%). The mean of the response values for this question was 4.00, indicating that technology education teachers agree with this statement.

Question 12 stated "Time spent on STEM integration detracts from achieving technology literacy standards." One of 21 strongly agreed with this statement (5%). Three of 21 agreed with this statement (14%). Eight of 21 disagreed with this statement (38%). Nine of 21 strongly disagreed with this statement (43%). The mean of the response values for this question was 2.00, indicating that technology education teachers disagree with this statement. See Table 4 for complete summary of the findings.

Findings for Open-Form Questions

The survey also included three open-form questions, asking the teachers for specific strategies, methods, and lessons or interpreted units. The responses have been tabulated to group similar answers and ordered by frequency.

Question 13 asked "What specific planning strategies do you use in your technology education courses to integrate science, engineering, and/or mathematics?" Nine of the 21 responders collaborated with teachers of the other disciplines. Three used ITEEA's Engineering byDesign program (www.iteaconnect.org/EbD/ebd.htm). Several individual responses included:

Table 4

Frequency of teacher responses to survey questions

Question	SA	A	U	D	SD	**M**
1. It is important to integrate science, engineering and mathematics into technology education courses in order for students to develop higher order thinking skills and understand complex subjects.	18	3	0	0	0	**4.86**
2. You often integrate national or state **technology** standards in your technology education lessons.	17	4	0	0	0	**4.81**
3. You often integrate national or state **science** standards in your technology education lessons.	13	7	0	1	0	**4.43**
4. You often integrate national or state **engineering** standards in your technology education lessons.	13	4	2	1	0	**4.45**
5. You often integrate national or state **math** standards in your technology education lessons.	11	8	0	2	0	**4.33**
6. You are **asked** to integrate national or state **science** standards in your technology education lessons.	5	8	2	6	0	**3.57**
7. You are **asked** to integrate national or state **engineering** standards in your technology education lessons.	6	3	8	4	0	**3.52**
8. You are **asked** to integrate national or state **math** standards in your technology education lessons.	6	6	3	6	0	**3.57**
9. You get **support** from administration supervision to integrate national or state **science** standards in your technology education lessons.	11	2	6	1	1	**4.00**
10. You get **support** from administration supervision to integrate national or state **engineering** standards in your technology	12	2	4	3	0	**4.10**

education lessons.						
11. You get **support** from administration supervision to integrate national or state **math** standards in your technology education lessons.	12	1	4	4	0	**4.00**
12. Time spent on STEM integration detracts from achieving technology literacy standards.	1	3	0	8	9	**2.00**

Boston Museum of Science's Engineering the Future program (www.mos.org/etf), ITEEA's Idea Garden (www.iteea.org/Networking/IdeaGarden2010.mp4), Project Lead the Way (www.pltw.org/), and curriculum mapping (www.c21hub.com/pd/curriculum_mapping/).

Question 14 asked "What specific instructional methods do you use in your technology education courses to integrate science, engineering, and/or mathematics?" Five used lecture. Five used cooperative learning. Five used differentiation. Three teachers mentioned field trips, guest speakers, problem solving, project based learning, hands-on learning, and research assignments. Also mentioned were Kagan strategies, experimental projects, role playing assignments, brain based learning, understanding by design, demonstration, and technological journals.

Question 15 asked "What specific lessons/interpreted units do you use in your technology education courses to integrate science, engineering and/or mathematics?" Seven teachers used an architecture/structural engineering/planning unit. Five used a transportation unit. Three teachers indicated the following units: electronics, geometry, materials, dragsters, forensics, construction, and economics (costs). Other units mentioned were milling, robotics, software, laser engraving, statistics, rockets, Rube Goldberg machines, and mouse trap cars.

Summary

This chapter reported the findings of a fifteen question survey sent to 35 International Technology and Engineering Educators Association's Technology and Engineering Award winning teachers in the United States. Of the population of 35 teachers, 21 surveys were returned to the researcher (60%).

The first 11 questions were Likert-scale statements concerning STEM integration in technology education courses that all received an average positive response from the polled population. Question 12 was the sole Likert-scale statement with a mean negative response from the polled population.

The data collected from the open-form questions were a collection of planning strategies, instructional methods, and lessons or interpreted units. Some responses occurred frequently, but generally responses were varied and encompassing. The data from this chapter was used to reach conclusions and make recommendations to technology teachers and future researchers in Chapter V.

Chapter V

Summary, Conclusions and Recommendations

This study was conducted to find practices in place by some of the United States' top technology teachers to integrate science, engineering, and mathematics standards in technology education courses. The purpose of this chapter was to summarize the study, state reached conclusions based on the data collected, and for the researcher to make recommendations for future research.

Summary

The problem of this study was to determine technology education teachers' use of methods to integrate science, technology, engineering, and mathematics into technology education courses for improved student learning of complex ideas. The population of top technology education teachers was identified as 35 International Technology and Engineering Educators Association's Technology and Engineering Award winning teachers in the United States.

As guidance for the study, the following research questions were identified: 1) Are there common practices used by technology education teachers to integrate the STEM subjects into technology education courses? 2) How is the integrated technology classroom perceived by administrators? and 3) Do technology teachers feel that STEM subject integration takes away from time spent on achieving technological literacy standards?

The significance of the study was both to inform and provide resources to technology education teachers so that they may better integrate STEM subject standards into their technology education courses.

The following limitations were identified for this study:

- Some teachers of technology education courses might not integrate the STEM subjects through their teaching.
- The practices in use by teachers of technology courses might not be easily explained.
- Perception of the integration by those involved might not be significant.
- The time spent on technology education standards could be more important than time on other STEM subjects in some regions.
- The sample is of exemplary teachers; Technology Education Teacher of the Year awardees, but still a small sample compared to the entire population of technology education teachers.
- The study will be but a snap shot of current practices for what might be a very young concept in practice.

The survey used to compile data consisted of 12 Likert-scaled questions and three open-form questions. The survey was sent to the population of 35 technology education teachers initially on May 27, 2011, along with a cover letter explaining the purpose of the study. Follow-up correspondence consisted of electronic mailings and phone calls. Data collection was completed on August 2, 2011, with 21 of the 35 technology education teachers responding (60%). Once the surveys were collected, the researcher calculated the mean of the Likert-scaled questions as descriptive statistics. The responses for the open-form questions were tabulated and listed.

Conclusions

The problem of this study was to determine technology education teachers' use of methods to integrate science, technology, engineering, and mathematics into technology education courses for improved student learning of complex ideas. The data collected from the survey was tabulated and treated to address each one of the research questions.

RQ_1 was to determine if there are common practices used by technology education teachers to integrate the STEM subjects into technology education courses. This goal was addressed by survey Questions 1, 2, 3, 4, 5, 13, 14, and 15.

The data collected in these survey questions indicated that technology education teachers strongly agree that it is important to integrate STEM subjects in technology education courses. The teachers also agreed that they often integrate the STEM subjects in their technology education lessons. However, it seems that there are not clearly evident common practices used by technology education teachers to integrate the STEM subjects into technology education courses.

RQ_2 was how is the integrated technology classroom perceived by administrators? This goal was addressed by survey Questions 6, 7, 8, 9, 10, and 11.

The data collected from these survey questions indicated that technology education teachers agreed that they were asked and received support to integrate STEM subjects in their technology education lessons. This showed that administrators saw STEM integration as an important part of technology education courses.

RQ_3 was do technology teachers feel that STEM subject integration takes away from time spent on achieving technological literacy standards? This goal was addressed by Question 12.

The data collected from this survey question indicated that technology education teachers did not agree that STEM subject integration takes away from time spent on achieving technological literacy standards. Therefore they integrated the STEM subjects in their technology courses.

Recommendations

This study was conducted to find practices used by technology education teachers to integrate science, technology, engineering, and mathematics into technology education courses for improved student learning of complex ideas. Based on the findings and conclusions of this study, the following recommendations were offered:

- Technology education teachers need to utilize practices to integrate the STEM subjects in their technology education courses. This has been identified as something that top technology education teachers do and their administrators support and ask from them.

- A greater population of all technology education teachers need to be polled to better determine what strategies, methods, and lessons are used to integrate the STEM subjects and at what frequency.
- Technology education teachers need to be polled to determine if they are aware of the strategies, methods, and lessons that top technology educators are implementing in their classroom. This needs to be done with closed-form survey questions, since some open-form questions on the subject were not responded well.
- Further research is needed to determine if certain strategies, methods, and/or lessons are used in specific technology education courses.
- Findings of further research needs to be widely communicated to technology education teachers in order for them to better educate their technology students.

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APPENDIX A

Survey Questions

Technology Education Teachers' Use of Methods to Integrate Science, Technology, Engineering and Mathematics into Technology Education Courses

Purpose: This survey will determine technology education teachers' use of methods to integrate science, technology, engineering and mathematics into technology education courses.

Instructions: Please rate how strongly you agree or disagree with each of the following statements by placing a check mark in the appropriate box.

Question	SA	A	U	D	SD
1. It is important to integrate science, engineering and mathematics into technology education courses in order for students to develop higher order thinking skills and understand complex subjects.					
2. You often integrate national or state **technology** standards in your technology education lessons.					
3. You often integrate national or state **science** standards in your technology education lessons.					
4. You often integrate national or state **engineering** standards in your technology education lessons.					
5. You often integrate national or state **math** standards in your technology education lessons.					
6. You are **asked** to integrate national or state **science** standards in your technology education lessons.					
7. You are **asked** to integrate national or state **engineering** standards in your technology					

education lessons.					
8. You are **asked** to integrate national or state **math** standards in your technology education lessons.					
9. You get **support** from administration supervision to integrate national or state **science** standards in your technology education lessons.					
10. You get **support** from administration supervision to integrate national or state **engineering** standards in your technology education lessons.					
11. You get **support** from administration supervision to integrate national or state **math** standards in your technology education lessons.					
12. Time spent on STEM integration detracts from achieving technology literacy standards.					

13. What specific planning strategies do you use in your technology education courses to integrate science, engineering and/or mathematics?

14. What specific instructional methods do you use in your technology education courses to integrate science, engineering and/or mathematics?

15. What specific lessons/interpreted units do you use in your technology education courses to integrate science, engineering and/or mathematics?

APPENDIX B

Sample Cover Letter

Dear survey participant,

Your participation in this voluntary survey will aid in research designed to discover and summarize excellent technology educator’s use of integration of the STEM subjects in technology education courses. You have been identified as an outstanding technology educator by the International Technology and engineering Educators Association, so your participation is critical to this research and to the betterment of STEM education.

Your response to this survey will be kept confidential. No information provided will be linked back to the participant. By you completing this survey you indicate your willingness for us to use your data in our study. Your answers will be aggregate so that your individual responses will not be personally identified.

This research will serve the research requirements for the STEM Education and Professional Studies graduate program in Community College Teaching.

Any questions you may have about this study can be directed to the investigator and supervisor listed below.

Name of Principal Investigator
Matthew B. Basilone
STEM Education and Professional Studies
Old Dominion University
Education Building Rm. 228
Norfolk, VA 23529

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mbasi002@odu.edu

I hope that you will be able to participate in this study.
Thank you for your time and consideration.
Sincerely,

Matthew B. Basilone