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A State-by-State Policy Analysis of STEM Education for K-12 Public Schools

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A STATE-BY-STATE POLICY ANALYSIS OF STEM EDUCATION
FOR K-12 PUBLIC SCHOOLS

By
COURTNEY C. CARMICHAEL

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL OF SETON HALL
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STATE-BY-STATE STEM EDUCATION POLICY ANALYSIS

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APPROVAL FOR SUCCESSFUL DEFENSE

Courtney C. Carmichael, has successfully defended and made the required modifications to the text of the doctoral dissertation for the **Ed.D.** during this **Spring Semester 2017**.

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I have had a winding academic path to doctorate. I completed my undergraduate degree at Northeastern University magna cum laude in journalism with a concentration in advertising and minors in political science and art. Also while at Northeastern, I fulfilled the Honors Distinction program requirements and studied at Studio Art Centers International in Florence, Italy. Later at Rutgers University, I earned a masters degree in education with a focus on social studies and went on to complete my educational specialist degree in education, leadership, policy and management at Seton Hall University before finishing the doctorate program in K-12 education.

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ABSTRACT

For practitioners and policy makers across the nation, STEM education has a vague definition. This study looks at how all 50 states define STEM education in policy, using four models: (a) Disciplinary STEM (Science, Technology, Engineering, Mathematics); (b) Integrated STEM focusing on combining two or more disciplines to produce critical thinking, real world application, and creative problem solving; (c) the Disciplinary and Integrated STEM model that acknowledges both to summarize programs at the state policy level; (d) the model with no definition of STEM education. The final results include 10 percent of states use the first model, 42 percent use an Integrated definition, 30 percent use both Integrated and Disciplinary terminology, while 18 percent have no definition in policy documents. Content analysis was used to determine what each state used while looking at documents such as bills, statutes, regulations, executive orders, strategic plans, state-sponsored websites, and press releases. Secondary content analysis was used to determine states' goals and aspirations with STEM education at the policy level. The following include the overall results of the goals and aspirations of the states: 78 percent of the states related STEM education to workforce or economic development, 68 percent suggested STEM education is for all students and not just special populations, 56 percent wanted to improved minority participation in STEM fields, 30 percent used Career and Technical Education programming as the primary STEM source of education delivery, 18 percent of the states wanted to use afterschool programming for STEM Education, and 16 percent wanted to improve STEM education in the state by offering more advanced coursework like Advanced Placement courses in the high schools. The

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study also provides an overview of the federal Race to the Top grant program and its STEM competitive initiative (2010).

Keywords: STEM education, state policy analysis, content analysis, Race to the Top, career and technical education, gifted education, economic development

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Chapter 1

Introduction

In 2001, Dr. Judith Ramaley of the National Science Foundation (NSF) was working on curriculum for science, technology, engineering, and mathematics. The current acronym of the time was known as SMET. As former director of the NSF, Dr. Ramaley changed the acronym to STEM and it has emerged one of the hottest curricular issues of the last decade (Banning & Folkestad, 2012; Christenson, 2011; Egenrieder, n.d). The four disciplines as STEM have an impact in both the economic and education sectors, each with varying degrees of emphasis and influence regarding public policy.

STEM Education Policy

STEM education policy has been situated within a history of political and economical concern. STEM disciplines have been politicized since *A Nation at Risk* (1983), when education policymakers proclaimed American education troubled and unprepared for the scientific and technical fields, “Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world” (Gardner, 1983, p. 1). While the data eventually was debunked by the Sandia Report (1993), the public’s unease of failing to live up to economic dominance and education superiority led to an emphasis on greater science and mathematics coursework for all public school students, ensuring that students earn credits in those fields. According to the National Center for Education Statistics High School Transcript Study (HSTS) (2009), students have increased significantly the number of credits related to science and mathematics courses from 1990 to 2009. For

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mathematics, the average increased from 3.2 to 3.9 credit hours, and for science, the average increased from 2.8 to 3.5 credit hours ($p < .05$). The percentage of high school graduates with advanced mathematics coursework also increased significantly from 1990 to 2009, increasing from 57 percent to 84 percent ($p < .05$). Advanced mathematics courses include Algebra II, pre-calculus, and calculus. Likewise, the percentage of graduates taking advanced science and engineering courses increased from 61 percent to 86 percent in the same time frame ($p < .05$). Courses include advanced biology, chemistry, advanced earth science, physics, and engineering. Also according to the HSTS (2009), the percentage of students who graduated with STEM-related technical courses increased from 29 to 31 percent, albeit not statistically significant. A related course like computer science decreased from 25 to 19 percent of students, a significant difference ($p < .05$). Students who graduated with health science plateaued from 3 percent to 9 percent also statistically significant over a 19-year period ($p < .05$).

Technological advances in personal computing, and information dissemination and creation since the 1990s have brought greater innovation to the general education classroom (Marshall, 2002). Technology shifted from technical education and vocational fields to technical computing. Traditionally, engineering was not taught for all students, yet it has been introduced in recent curriculum standards. For the first time in K-12 classrooms, Next Generation Science Standards, adopted by many states in 2013, included engineering concepts to be taught in a systematic way using the design process, such as defining problems, using models, improving the technological system with data analysis, and designing solutions (Cowen, 2013). Later research in this study will show

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that the current education, political, and economic climate at the state and federal level has led to greater emphasis on STEM education.

A Prepared STEM Workforce

STEM education policy has been linked to the economic sphere for both national growth and personal financial gains. Several advocacy groups promote STEM education as a way to improve economic resources such as increasing university graduates and those who are certificated in STEM fields (CoSTEM, 2013; Council on Foreign Relations Independent Task Force, 2015; NAS et al., 2011; NRC, 2011; STEM Education Coalition, 2015). These advocacy groups have controlled the STEM policy narrative, ignoring the positive research that has suggested the STEM outlook has not been as dire as predicted (Gereffi, Wadhwa, & Rissing, 2006; Lowell & Salzman, 2007; NCES, 2009; Salzman, Kuehn, & Lowell, 2013). Lowell and Salzman (2007) reiterated statistics similar to the NCES Transcript Study (2009), more students are taking math and science courses in high school, as more states require the advanced coursework towards graduation. Lowell and Salzman (2007) have also suggested that flooding the market with an increased amount of qualified individuals has been an inefficient way to meet demand, in a market already more than sufficient with human capital. Gereffi et al. (2006) concurred when they found that America graduates annually near double the amount of students with computer technology and engineering bachelor's degrees that are usually cited by media reports. Salzman et al. (2013) found that American universities graduate so many in STEM fields that about half must find work in other fields not STEM related. Yet STEM advocacy groups have repeated over and over that education must focus on STEM. A recent advocacy piece given to presidential candidates of 2016

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for both parties from the STEM Education Coalition (2015) suggested, “Advancing science, technology, engineering, and mathematics (STEM) education for American students must be a central element of a broad-based agenda to promote U.S. prosperity and innovation. STEM education is closely linked with U.S. economic success” (p. 1).

Educators and policy makers should understand what the goal of the STEM education should be for the students. Yet as an economic consideration, STEM field(s) can be difficult to define. Federal agencies have differing definitions to what constitutes the STEM workforce. The Bureau of Labor Statistics and the Department of Labor use criteria similar but different enough to vary the STEM classifications. Depending on the definition, the economic impact varies in both amount of people and companies involved in STEM as well output. The lack of coherent definition is an admitted problem as the Standard Occupation Classification Policy Committee (SOCPC) has been looking into defining STEM occupations for the Bureau of Labor Statistics’ (BLS) release of SOC for 2018. Depending on the classification type, job estimates range from 5.9 million to 26 million with average salaries ranging from \$50,000 to \$96,000 (Oleson, Hora, & Benbow, 2014).

STEM has significant impact in the US economy, yet the definitions of which fields were considered STEM have been confusing. In the United States of America, STEM workers were estimated to be between 5.9 million to 26 million (Oleson, Hora, & Benbow, 2014). For example, health care workers were often excluded as STEM workers. Yet health care jobs could be considered science related careers. Sometimes, only fields requiring a college degree were used to calculate the jobs, not including the STEM-related positions that need certificates and not degrees. How the range was

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determined and problematic, however, the impact of STEM in the economy was pronounced. According to Rothwell (2013), using the 26 million estimate including all related work forces, STEM was 20 percent of all jobs. Using this statistic, therefore, the number of STEM related workers would be considered up from ten percent since the 19th century's Industrial Revolution. Looking to the future for expansion, according to Langdon et al. (2011), STEM positions were projected to grow by 17 percent from 2008 to 2018, compared to 9.8 percent growth for non-STEM occupations.

BLS uses the Standard Occupation Classification which included the following characteristics to group occupations: "similar job duties, and in some cases, skills, education and/or training" (Oleson, Hora, & Benbow, 2014). When it produced a report analyzing occupations from six groups, including computer and mathematics; architecture and engineering; and life, physical, and social sciences, the BLS excluded health occupations from STEM as a separate category (Vilorio, 2014). Yet, at times, it did include health occupations, totaling 184 STEM occupations in 2010 (SOCPC, 2012).

In contrast, the Department of Labor's O*Net classification system, lists 166 STEM occupations which included "occupations in the same field of work that require similar skills" (Oleson, Hora, & Benbow, 2014). O*Net and SOC have both been used by researchers yet there is a difference between tasks (SOC) compared to skills (O*Net).

Furthermore, the NSF used a higher education standard beyond a vocational or industry certificate, which included as part of the definition of STEM those holding a science or engineering post-secondary degree. Through their classification system, the NSF narrowed the list of occupations down to only 62 jobs based on SOC classification (Oleson, Hora, & Benbow, 2014). As each agency has used different classifications for

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job numbers, wages and job outcomes may also vary. For example, the SOC wage average is around \$80,000, while the NSF has a range of \$65,000 to \$78,000 (Oleson, Hora, & Benbow, 2014). Wages and job outlook can be important when factoring in education and training needed for these occupations.

Regardless of job outlook based on the classification system, Oleson, Hora, & Benbow (2014) concluded that earning at least some post-secondary degree is worth approximately \$1.6 million more of the course of a person's lifetime than a high school diploma. Although they differ in classification, agencies argue education should focus on STEM to meet the economic needs of the country. The federal government, therefore, has been concerned with STEM workforce readiness resulting in over \$4.3 billion spent by the federal government for 255 distinct education programs with the goal of producing more STEM workers. One-third of the money has been earmarked for K-12 programs, while the rest has been distributed between on the job training and university programs (Rothwell, 2013). Educating America's children has been paramount to promote the growth model of increasing the number of those affected by STEM education to support a competitive global marketplace. Meaningful dialogue of what was considered STEM in the workforce and in education has been productive by our education policy experts.

STEM Education as Federal Initiative

While our confederate-like system of Departments of Education operate independently, federal policy and grants help transform the educational agenda. In recent years, federal education policy and funding has aimed to promote STEM (CoSTEM, 2013; NAS et al.; NRC, 2011; 2011; U.S. Department of Education [USDOE], 2010). The influence of the federal grants was illustrated by two major federal agencies. The

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Department of Health and Human Services (HHS) and the NSF have been the two largest agencies financially supporting STEM education based around the following conclusions:

(a) America did not have enough STEM workers, (b) educators needed to support minorities in STEM fields, and (c) the general public should understand STEM concepts better (NSF, 2012). The previous three claims have supported the STEM education rhetoric and have not been proven quantifiably and have been repeated without a discerning eye. Each agency has taken its own approach of support that illustrates the range of STEM applications in education (e.g., CoSTEM, 2013; NAS et al., 2011; NRC, 2011).

As national agencies and states' departments of education have grappled with STEM initiatives, so too has the 2008-2016 White House which called upon educators to take on STEM education. While for the last fifteen years, STEM has been a matter of concern for education policy makers and economists, President Barack Obama brought STEM into the forefront with the Race to the Top program:

America will not succeed in the 21st century unless we do a far better job of educating our sons and daughters... And the race starts today. I am issuing a challenge to our nation's governors and school boards, principals and teachers, businesses and non-profits, parents and students: if you set and enforce rigorous and challenging standards and assessments; if you put outstanding teachers at the front of the classroom; if you turn around failing schools – your state can win a Race to the Top grant that will not only help students out compete workers around the world, but let them fulfill their God-given potential. (Office of the Press Secretary, 2009)

His speech drew attention to both educators and the business sector regarding education policy. He bundled STEM readiness concerns with the Race to the Top initiative, a large education funding competition that began in 2010 to support state education programs (USDOE, 2010).

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While STEM was only a component of Race to the Top, it was identified as a competitive funding priority. With the federal government supporting STEM initiatives as part of the RTTT grants, subsequently individual states developed policy to address the STEM funding priority in their applications. Not all states applied to RTTT with the STEM component, nor did all states apply for the program (for a list of states who applied, see Appendix A). About 20 percent of the state departments of education did not compete in the first round of RTTT funding and therefore no application exists for research purposes (USDOE, 2010). Other documents written by governmental officials and representatives address STEM education policy.

Defining STEM Education

Seeing what the agencies that supported the American workforce face in defining STEM, the education arena has confronted a similar dilemma regarding its definition models. Government officials, teachers, administrators, and the public have heard about STEM education for more than a decade but many could be hard pressed to define STEM education. The education field has been challenged with the following questions: Is STEM Education the sum of the STEM related programming - compiling the programs of science, technology, engineering, and mathematics coursework? Or is it schools that can take on the integrated model - the four disciplines used in concert promoting critical thinking with specifically designed curriculum? The media have promoted STEM activities in schools. In local newspapers, public school districts have publicized their STEM initiatives. Education Week (2009) gathered together a collection of articles featuring STEM in schools with titles such as:

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- One public school's blending of the science, technology, engineering, and math disciplines
- Courses on renewable energy and 'green' technology
- Learning science through informal experiences and educational television
- Playing games in the classroom to strengthen students' math skills
- Using unconventional textbooks and other materials to help struggling middle schoolers become 'algebra-ready'

While all were noteworthy initiatives in schools, STEM could be about eighth grade algebra, renewable energy activities, or science instruction through television programming. It is hard to understand if these programs were any good without a common language. STEM in schools can receive a lot of press influencing parents and local politicians, with the added pressure that these STEM fields were considered by policymakers to be necessary for supporting our economic output (NAS et al., 2011; NRC, 2011). Looking at the nuances of what is STEM education creates an assortment of education jargon. In education, is STEM a verb - related to inquiry-based problem solving, or is STEM a noun - describing the academic disciplines and units of study for students? If teachers ask our students to pick up the torch for STEM, what do educators mean when they implement STEM education policy? But first, before answering that question, the research must discover and lay out the definitions used in education policy. This study focused on that aspect of the research.

Purpose of Study and Research Questions

The purpose of this study was to examine analyze state policies regarding the definitions of STEM education within the United States. The policy analysis allowed the researcher to analyze the following questions:

1. Did a given state and/or commonwealth define STEM education?

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2. When a state and/or commonwealth defined STEM education, did the policy/statute use an integrated definition of STEM, the disciplinary definition, or both?
3. What was the given state's vision for STEM regarding goals and aspirations?
 - a. Does the vision attempt to address underrepresented groups in STEM education?
 - b. Are the goals of STEM education tied to economic output?
 - c. If STEM education policy exists, do STEM programs target isolated populations, like after school, gifted enrichment, or advanced placement, or are the programs focused on the larger, general population for all?

Significance of the Study

This study is significant because STEM education definitions may influence curriculum and goals and objectives of public schools. Policy formed by legislators, governors, and other bureaucrats influence the educational landscape in the classroom. Even though the economic realm does not agree on a STEM definition, language related to how STEM education has been defined at the policy level has continuing influence within the realm of practice. RTTT (2010) encouraged states' departments of education to have STEM education programs. In consequence, this study provides a state-by-state analysis of STEM definitions by policy makers. While a number of states and education policy advocates have STEM education definitions, a comprehensive examination of the policy language does not exist. As a policy study, the research should fill the gap.

Limitations

STEM has been considered a global education issue yet this study only looks at United States policy as implemented and identified by the fifty states. Also while the territories and District of Columbia have STEM and receive federal funds, for the

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purposes of this study they were excluded for practical analysis since they do not have the same organizational structure of government.

While advocacy groups have encouraged STEM programs, including federal and state organizations, this study does not evaluate whether STEM education is necessary. STEM education is used in schools across the United States; consequently, the policy surrounding the programs is included in this study.

Although STEM existed in various forms before 2001, the definition of STEM and related documentation did not exist in any large quantity until 2009. Searches were made for materials prior to Race To The Top (2010) but very limited source material has been published and there is no way to test the hypothesis that RTTT was the catalyst or just part of a confluence of events with STEM rising in education policy. RTTT will also not be evaluated as to whether the funding scheme was effective in raising education goals in the United States.

Defining STEM education is a constantly changing field as policy makers alter the landscape. The Department of Education for New Jersey, for example, did not publically have a definition before August 2016 (New Jersey Department of Education [NJDOE], 2016). Therefore, state-by-state research was conducted from September 2015 to October 2016 and the definitions presented are limited by time.

The addition of whether or not Art should be added to the STEM acronym was not included in the research questions. STEAM has been a term used by schools to describe programming, so has STREAM (Religion – sometimes Reading), STEEM (Entrepreneurship), or H-STEM (Humanities). The researcher did not find a body of literature related to these other acronyms and almost no policy documentation. Federally

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funded education programs and the labor market definitions relate to STEM and so the research was limited to the four-discipline term.

The study also did not examine how individual schools and non-profit agencies interpreted and implemented STEM as a definition. Implementation can vary due to local priorities, such as resources, curriculum models, and/or state statutes. STEM education can be expensive, as it requires a wide range of objects, teachers, and space. Language arts and mathematics on their own could be argued as courses that were the priorities of schools due to emphasis on being standardized test subjects, so that STEM may be a lower priority. STEM programs also vary widely in cost. The study also did not address how well STEM addresses student achievement or how STEM education is funded in the K-12 setting both of which could be different topics for other studies. Finally, the researcher will not offer a preferred definition of STEM education. The research will draw upon what has already been stated in the public arena.

Definitions of Terms

21st Century Skills – Classroom pedagogy based in critical thinking and problem solving; creativity and innovation; communication and information; collaboration; contextual learning; and information and media literacy are considered 21st Century Skills (P21, n.d.).

Career and Technical Education – CTE is a course of study that prepares students for postsecondary opportunities in the workplace and college related to vocational skills. The federal government's Carl D. Perkins Career and Technical Education Act may financially support schools with CTE programs (Association for Career and Technical Education, 2016; USDOE, 2016).

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Gifted education - In the education context, gifted refers to the education opportunities for advanced, honors or students identified as gifted. Gifted education is usually separate for the general education programming (Gagne, 1985; No Child Left Behind, 2002; Renzulli, 1978).

Race to the Top - RTTT is known as the competitive federal funding initiative that states applied to initially in 2010. There have been several phases of funding. Over \$4 billion has been granted to the states in three phases of funding. All applications are available on the U.S. Department of Education's website (USDOE, 2015; 2016).

STEM - In this study, STEM is the collective disciplines of Science, Technology, Engineering, and Mathematics.

STEM-ED - STEM-ED is the integrated model of STEM whether two fields together or all four. It primarily uses problem-based learning or inquiry based lessons to promote critical thinking.

Organization of the Study

Chapter 1 was provided to illuminate the background of STEM education policy in America's public schools. In Chapter 2, the methods for data collection are explained. The overall format and structure of the study is addressed. Chapter 3 followed a review of the literature of state-by-state collection of STEM policy terminology. Chapter 4 synthesized the terminology related to STEM education and analyzed the goals and aspirations of state education policies. Chapter 5 provided a summary of the findings and synthesized the research conclusions.

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Chapter 2

Methodology

The following chapter has been devoted to how the researcher conducted an examination into STEM education policy and definitions state by state.

Study Design

Several methods were used to understand and meet the research objectives. The following documents were examined for STEM education policy priorities and definitions. Public policy can be formed by individuals such as governors, government organizations like departments of education or boards of education, and put into law and statute by legislative branches or courts (Anderson, 2003; Birkland, 2011). Advocacy groups can also get involved to represent public interests, in this case non-profit education groups (Anderson, 2003). As part of the framework of the study, Race To The Top applications addressed related policy in the states that applied (Appendix A). When an application did not exist, as in the case for ten states, or was not adequate to define STEM, other state authored documents were used (see the list of states in Appendix B). The list of public policy documentation included: statutes, bills, press releases, and websites sponsored by government agencies. Several non-profit organizations were found to address STEM education. Attempts were made to exclude the private organizations and non-profits as variables by the researcher by examining ownership of the websites. If neither a department of education nor a government organization was listed as a partner in the non-profit than the private organization was excluded as a source. In addition, while the researcher made attempts to find documentation sponsored by government

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officials, at times, supporting materials by independent non-profits funded in part by the state education departments were used to flesh out terminology and policy goals.

Search terms included: “<<named state>> STEM education,” “STEM education policy.” Searching using Internet browsers were made first, followed by searches on government websites including legislative and executive branches, which produced a number of bills and administrative codes related to STEM education initiatives (see the references).

Analysis Framework

Summative content analysis, as described by Hsieh and Shannon (2005), was conducted to further understand the policy context of STEM education. It was completed in three stages. The first stage was to collect the data to be studied. Content analysis included quantitatively listing whether or not terminology related to STEM education in each state came from policy related websites, publications or reports, and/or from legislation or statute. This was compiled using a spreadsheet. These represent the types of communication that are part of policy (Peterson, 2008).

Table 2-1 Coding agenda for STEM Education usage

Category	Definition	Coding Rules
a) STEM	Science, technology, engineering, and mathematics	Used when four disciplines were listed alone.
b) STEM-ED	Science, technology, engineering, and mathematics in interdisciplinary or transdisciplinary functions	Used when at least two disciplines were listed with words like interdisciplinary, multidisciplinary, transdisciplinary, integrated, integration, combined together, promote creative thinking, authentic learning, or problem-based learning.
c) Both STEM definitions	STEM and STEM-ED described educational programs in the state	Used when both STEM as disciplinary and STEM as integrated model are talked about in the literature applying to state policies.
d) No STEM definition	STEM was not described as acronym or interdisciplinary model	Used when only “STEM” was employed in media sources.

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In stage two, regarding the textual evidence relating to STEM education policy, the first step included identifying and quantifying words that bring greater interpretation concerning usage (see Table 2-1). The researcher was particularly interested in how states defined STEM education and the rhetoric surrounding the terminology (Banning & Folkestad, 2012; Christenson, 2011; CoSTEM, 2013; Egenrieder, n.d; Eisenberg & Eisenberg, 1998; Kohler, & Hallinen, 2009; NRC, 2012; Sidawi, 2009; Tsupros, Vasquez, 2015; Vasquez, Sneider, & Comer, 2013). The coding agenda was based on research related to terminology used when discussing STEM education. The researcher examined policy documents, legislation, statutes, executive orders, and various media produced by the stakeholders in each state related to STEM education. With summative content analysis, keywords were derived from the literature before and during the study (Hsieh & Shannon, 2005). When necessary and not obvious to the researcher, latent content analysis was used to go beyond word counts but to explain content qualitatively (Becker & Lissman, 1973; Krippendorff, 1969; Mayring, 2000). According to Green Saraisky (2015), content analysis must go beyond the literal word meanings to understand the attitudes, culture, and institutions in the policy sphere. Ultimately, patterns and meanings are derived from the analysis using the coding agenda. So while the researcher first analyzed and counted whether or not certain words and phrases were used in each state's documentation and studied the STEM education quantitatively, it was also necessary to analyze direct or rhetorical words to discover conclusions related to the research questions. The technique led to proximity analysis, which used the co-occurrence of words and phrases. Busch et al. (2012) suggested that proximity analysis might be good for explicit analysis but problematic with closeness to meaning. The

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researcher has to have clear idea and coding rules to interpret effectively. However, Busch et al. (2012) liked content analysis for the ability to be both quantitative and qualitative, it can provide historical and social analysis particularly useful with policy, and has been considered unobtrusive when studying the issue. In contrast, according to Busch et al. (2012) content analysis may be subject to errors regarding definition interpretation, drawing upon liberal interpretation and implicit understanding related to the researcher's biases. Going beyond the STEM education definitions led to further research questions relating to the goals and aspirations of each state (see Table 2-2). Analysis of the research questions regarding goals and aspirations was the third stage for the researcher. Six categories were created to answer the research questions: if the state addressed (1) economic goals, (2) underrepresented minorities such as female, African-Americans, or Hispanic students, (3) STEM education for all students, instead of (4) STEM education for afterschool groups, (5) CTE programs or (6) high achieving populations only.

To increase reliability, Bengtsson (2016) suggested multiple passes through the text once the coding has been initiated to insure that all categories are included in the coding agenda and properly categorized. Unfortunately, inter-rater reliability was unable to be accurately determined with only one coder. According to Hsieh and Shannon (2005), validity increases when the researcher has followed a coding agenda. Regarding the process, the data analysis was completed by hand and by computer when available, using highlighters to color code categories and terms. A spreadsheet was used to compile the resulting analysis. In the media and policy documents available, words were searched applying the coding rules.

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After frequency analysis and descriptive statistics were compiled using the content analysis procedure, further analysis studies were completed to describe the different groups (a, b, c, d) and whether there are differences related to the independent variables of the groups (1, 2, 3, 4, 5, 6). The results are found in chapter 4.

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Table 2-2: Coding agenda for STEM goals and aspirations

Category	Definition	Coding Rules
1) Economic	STEM education was related to economic goals of the state	Used when implicit or explicit economic terms were included such as improving labor, workers, or economic output are included with STEM objectives.
2) Underrepresented Minorities	STEM education objectives included women, Hispanic or Latino, African American or Black, and or Native American minorities.	Used when STEM education objectives mentioned the following underrepresented minorities in STEM fields. Terms included: women, Hispanic or Latino, African Americans or Black, and or Native Americans.
3) STEM for All	STEM education objective that included an increased in exposure of STEM for all students.	Used when policy explicitly stated STEM education was for all students not just gifted education, afterschool or career and technical education programming.
4) STEM for Afterschool programs	STEM education was for students who participated in summer programs or afterschool activities.	Used when STEM education was explicitly or implicitly stated for 21 st Century Community Learning Centers, college summer programs, or K-12 afterschool summer programs.
5) STEM for Career and Technical Education (CTE) programs	STEM has been listed as one of the sixteen career clusters by the federally supported CTE programs in all 50 states.	Used when STEM education was promoted or defined from CTE supporting documents.
6) STEM for high achieving populations	STEM education was geared toward enrichment such as gifted education or students in Advanced Placement courses.	Used when explicitly stated that STEM education was to be for Advanced Placement courses, magnet schools based on achievement, and gifted education programming.

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Chapter 3

Review of Literature

A significant body of literature has discussed how STEM can be implemented into schools and the resulting policies (e.g. CoSTEM, 2013; Eisenberg & Eisenberg, 1998; NRC, 2012; Sidawi, 2009; South Carolina Department of Education [SCDE], 2014). States' departments of education and government officials have begun to address the needs of STEM in their schools in varying degrees. Subsequently, the definitions of STEM education have been derived from various source material including state sponsored websites for government agencies, grant applications, press releases, statutes, passed and pending bills, and executive orders.

Background of STEM education

Various federal laws have been focused on the STEM subjects since National Defense Education Act (1958) established greater emphasis in education programs in response to Sputnik and foreign competition. STEM education rhetoric has spoken repeatedly about how students in the United States come up short. While the following statement could have been written in 1958 or 1983, it is from a more recent examination of economic prosperity and educational progress: from *Rising Above the Gathering Storm* (2011), "Having reviewed trends in the United States and abroad... deeply concerned that the scientific and technical building blocks of our economic leadership are eroding at a time when many other nations are gathering strength" (p. 3). The dire warning from *Gathering Storm* (2011) is backed by the National Research Council (2011) who noted that according to the National Assessment of Educational Progress (NAEP), 75 percent of eighth graders were not proficient in mathematics and for the Trends in International

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Mathematics and Science Study (TIMSS), eighth graders were at 10 percent advanced compared to 32 percent in Singapore or 25 percent for Chinese students. The NRC is the research arm for the National Academies of Science, Engineering and Medicine, which have an invested interest in promoting education related to these fields. What marks the term STEM education different than before is the increased attention to improving integration with technology and engineering as added educational aims. The business and commercial arena have asked for improved STEM education to meet the demands of the growing and emerging job market. “Focusing on how to teach, train, and acquire a broader set of skills beyond just technical expertise in a single field is one of the ways that the United States can cultivate a workforce that will be prepared to succeed in the 21st-century economy and beyond” (Oleson, Hora, & Benbow, 2014). The convergence of STEM education and workforce objectives had been marked with competitive underpinnings in the global arena.

While essentially debunked by independent research (Gereffi, Wadhwa, & Rissing, 2006; Lowell & Salzman, 2007; NCES, 2009; Salzman, Kuehn, & Lowell, 2013), the prominence of various advocacy groups (e.g., CoSTEM, NRC) repeat the following three goals have been set forth from NRC (2011) to improve the state of STEM in the United States. These goals were to: (a) increase the number of students who pursue advanced degrees including women and minorities, (b) enlarge the STEM workforce and increase women and minorities in those numbers, and (c) develop the STEM literacy for all students whether in STEM fields or not. As a concluding statement from the NRC (2011), effective STEM learning should begin not just at the secondary level, but also at

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the primary grades. STEM education, therefore, should concern not just the collegiate level but be a focus down to the elementary schools.

The Federal STEM Strategic Plan - CoSTEM (2013), written after STEM funding was promoted in *Race to the Top*, suggested STEM education must be improved for three reasons: (1) “The jobs of the future are STEM jobs,” argued that the number of professionals needed will outpace the supply of properly trained workers. (2) The elementary and secondary schools were only “middle of the pack” compared to other Organization for Economic Cooperation and Development (OECD) with science and mathematics results on the Programme for International Student Assessment (PISA). Finally, (3) STEM is “critical to building a just and inclusive society” including minorities and women.

While CoSTEM (2013) has aligned itself to popular rhetoric that suggested the United States education has not prepared its students particularly in regards to science and mathematics, research such as Lowell and Salzman’s (2007), Salzman et al.’s (2013), Tienken’s (2013, 2014), and Sjoberg’s (2012) counter the CoSTEM (2013) premise of the US underperforming in education and the economic sector in science and mathematics. For example, as cited by Tienken (2014), when looking at patents the US has overwhelmingly dominated, has produced more scientific papers cited by researchers than any other country, and finally the PISA does not correlate to G20 competitiveness in the global economy. “The supposed cause and effect link between international test rankings and economics for the largest economies on the planet is a fallacy” (Tienken, 2014, p. 14). Based on the above research, STEM education policy might not need to be a priority for states to adopt.

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Finally, while the research suggesting that the US has established its place as an economic powerhouse and education juggernaut, more common themes with STEM education have arisen in supporting STEM education initiatives that counter the research. The themes have suggested that STEM education has economic impact, that the entire workforce, including minority groups, need to be prepared, and that the populace can benefit from the critical thinking, creativity, problem-solving skills developed in STEM school rooms.

STEM in the Classroom

STEM education programs have materialized in many forms; some could be deemed traditional, like Advanced Placement or International Baccalaureate coursework related to the STEM fields, others can be considered integrated as STEM-ED corporate-driven curricular materials like Project Lead the Way, Engineering By Design, Hour of Code, Engineering is Elementary, or Lego Mindstorm Robotics which can be adopted for in-school or after school programming. Still other classrooms have used STEM civics programs involving environmental sciences, health fields, bridge building, etc. to illustrate more specific concepts. Also, some states may use STEM initiatives targeted for gifted populations, as a magnet or charter school, or career and technical programs of study. These were all aimed at smaller populations than full integration in comprehensive public school settings. Some have been established as silo disciplines - alone without integration - STEM and others were integrative STEM-ED.

Since it did not come up in the state-by-state research, the following explanation of STEM education has not used as a framework for the purposes of this study but served to provide further background on STEM levels of infusion. Researchers Vasquez,

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Sneider, and Comer (2013) posited a four-stage inclined plane of STEM integration. For stage one (Disciplinary), STEM was defined by separate disciplines with individual skills and concepts. The disciplinary stage was similar to the sum total of Science, Technology, Engineering, and Mathematics coursework. The next stage (Multidisciplinary) was approached as each distinct discipline with a common theme. For stage three (Interdisciplinary), education has used two or more subjects that were “tightly linked” to provide greater depth in learning. The interdisciplinary model would support the federal programs under Mathematics and Science Partnerships (MSP) to train teachers in these fields together. Finally, stage four (Transdisciplinary) had an adapted curriculum that may feature real world problems to apply knowledge in two or more disciplines. Integrated STEM-Ed would fall under the transdisciplinary category. Vasquez (2015) has suggested that the levels of integration increase along a plane and they can be harder to execute in schools the higher the level of integration.

STEM education has been linked to improved student outcomes and aligned to national economic and educational objectives. STEM programs in general support student achievement (Cantrell, Pekcan, Itani, & Velasquez-Bryant, 2006; Elliott, Oty, McArthur, & Clark, 2001; Stohlmann, Moore, & Roehrig, 2012; Stohlmann, Moore, Roehrig, & McClelland, 2011), that professional development and colleges should support STEM teachers (Henderson & Dancy, 2011; Kimmell et al., 2014; Stohlmann, Moore, & Roehrig, 2012), and that STEM programs in public schools produce students interested in pursuing STEM careers (Aschbacher, Ing, & Tsai, 2014; Dubetz & Wilson, 2013; Hall et al., 2011; Knezek et al., 2013; McNally, 2012). With the previous supporting research, it has been made clear that STEM education programs support

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federal and state policy objectives.

STEM as an Education Priority

The Race to the Top (2010) federal grant program set STEM education as a competitive priority to help each applicant be awarded funding. Forty states and/or commonwealths applied in the first phase to the federal funding program (plus the District of Columbia). Of these, only 31 earned the full credit from the narrative description of each state's STEM education offerings. The entire application was graded and applicants earned points. STEM as a Competitive Funding Priority was only three percent of the overall possible score (15 points out of 500). Based on final tallies, only eighteen state programs received Race to the Top funding in three phases of awards. Some states did not apply in the first phase of initial funding but applied by the third round (Appendix C). Only four states never applied to Race to the Top: Alaska, North Dakota, Texas, and Vermont. Aspects of STEM, however, have been found in states with or without Race to the Top funds and other federal grants from organizations like NSF and NASA have supported STEM in schools. MSP grants have been established in every state, Puerto Rico, and the District of Columbia to support STEM in the classroom. MSP has provided training for teachers since 2002 (U.S. Department of Education [USDOE], 2015). On their own, many states' education departments based on executive or legislative action have established STEM resources and policies. Businesses and corporations also support STEM initiatives, often teaming with state education policy organizations to provide grants and mentoring opportunities.

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State STEM Education Initiatives since Race to the Top

The following states applied for Race to the Top funding and were awarded grants in three phases. Existing STEM programs did not guarantee Race to the Top funds, nor did Race to the Top require STEM as an educational priority in the application process. A state could be awarded funds without filling out the STEM part of the application. Eleven states plus the District of Columbia were awarded Race to the Top grants in the first and second rounds in 2010 include: Delaware, Florida, Georgia, Hawaii, Maryland, Massachusetts, New York, North Carolina, Ohio, Rhode Island, and Tennessee. Seven additional states were awarded Race to the Top Funds in 2011 for the third round: Arizona, Colorado, Illinois, Kentucky, Louisiana, New Jersey, and Pennsylvania. Louisiana, Arizona and District of Columbia did not receive credit for STEM in the first round of the application process. The application provided a framework for this research and categorization of state policies.

Most applications did not define STEM education but spoke of program initiatives. The language of STEM programs, therefore, was found most often in other documents produced by the legislative and executive branches of state governments.

Phase 1

Only two states, Delaware and Tennessee, were awarded Race to the Top funds after the initial Phase 1 in March of 2010. Both states had STEM education as part of their applications and received 100 percent toward each state's answer in the grant application (USDOE, 2010).

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Delaware

Delaware's STEM Council has been co-sponsored by the Department of Education, the state government, and several local universities. It was started from the phase one Race to the Top grant. The basic STEM definition for Delaware was defined by the acronym, as "These disciplines are vital for thriving in the 21st century whether managing STEM-based decisions of daily life or pursuing STEM careers" (Delaware STEM Council, n.d.). Delaware also has an integrated STEM-ED definition. From the STEM Council's annual report in 2012,

STEM Education is an approach to teaching and learning that emphasizes integration of science, technology, engineering, and mathematics for all students through student-focused, problem-based curricula and instruction. STEM education fosters creativity and innovation while developing communication, collaboration, and critical thinking skills through a focus on authentic and appropriate contexts in curriculum and assessment. (DE STEM Council Intro. section, para. 1)

The Delaware STEM Council's mission is related to the three main goals of STEM: promote students to pursue advanced degrees and careers in STEM fields including women and minorities, improve the workforce, and increase STEM for all students (Kaufman & Wagner, 2012).

Tennessee

The state of Tennessee used part of phase one Race to the Top funding to found the TN Innovation Network in 2011. Governor Phil Bredesen signed executive order 68 in June 2010, establishing the network run by Battelle Memorial Institute of Ohio and the University of Tennessee. The mission of the Network is (a) Increase student interest, participation, and achievement in STEM, (b) Expand student access to effective STEM teachers and leaders, (c) Reduce the state's STEM talent and skills gap, and (d) Build

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community awareness and support for STEM (thetsin.org, 2016). The TN Innovation Network produced an advocacy kit on the website in 2012,

Many Tennesseans still think STEM education is entirely about science, technology, engineering, and mathematics. We need to help people understand that STEM is more than an acronym—it's a philosophy for teaching and learning, a transformative public-private approach to education that uniquely engages formal and informal partners from K-12, higher education, and business. We need to communicate that STEM education is a logical response to a changing world, a new way of teaching and learning for all students, and an approach to developing the creative, critical-thinking, and problem-solving skills that all Tennesseans need to be successful in today's world. (Duncan, 2012)

The TN Innovation Network was a two-pronged approach. First, the Platform Schools (often magnet schools) try out STEM teaching and then they train other teachers with “local STEM industry partners, integrated curricula, and emphasize technology as a way to enhance teaching and learning” (Tennessee Innovation Network, 2016). The Network is broken into six regional networks of K-12 schools, colleges and universities, and businesses called Innovation Hubs. By August 2016, STEM programs of joint ventures of private enterprise and public support associated with STEMx has been used in twenty-one states. Overall, the Network, like it did in other states, has suggested that the goals of STEM help prepare for a global economy.

Seemingly a separate program outside of the Network, other searches on Tennessee governmental sites lead to STEM as part of CTE in Tennessee. STEM is one of the 16 career clusters for career and technical education. From the TN CTE website,

Given the critical nature of much of the work in this cluster, job possibilities abound even in times of economic downturn. More scientists, technologists and engineers will be needed to meet environmental regulations and to develop methods of cleaning up existing hazards. A shift in emphasis toward preventing problems rather than controlling those that already exist, as well as increasing public health concerns, also will

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spur demand for these positions. (Tennessee Department of Education, n.d.)

The federally supported, CTE program appears to fit within the overall goals of STEM in Tennessee, especially with economic aspirations for the state.

Phase 2

Still in 2010, a few months after Delaware and Tennessee were lauded with winning Race to the Top, Phase 2 awardees were granted federal funds from Race to the Top. The following nine states - Florida, Georgia, Hawaii, Maryland, Massachusetts, New York, North Carolina, Pennsylvania, and Rhode Island - all had 100 percent on the STEM competitive priority in their initial application to the Department of Education (USDOE, 2010). They are listed in alphabetical order not by the score they received in the applications.

Florida

The Florida Department of Education used the phrase “intentional integration” to describe STEM education with an outcome to

...create a student-centered learning environment in which students investigate and engineer solutions to problems, and construct evidence-based explanation of real-world phenomena with a focus on a student’s social, emotional, physical, and academic needs through shared contributions of schools, families, and community partners. (Florida Department of Education, 2016)

Florida’s mission-like stance recognized the economic impact for the state as well as the future earnings of the citizens. Unlike other states, Florida immediately drew upon Career and Technical Education programming as a priority and that STEM is beyond the four academic disciplines. Similar phrasing suggested that STEM is for all students, increasing participation at large and for those underrepresented subpopulations. However,

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according to *STEMFlorida* (2012), “STEM programs are in no way limited to Career and Technical Education (CTE) programs.” Indeed, Florida promoted on the website that STEM should be for all,

Programs should strive to increase the number of students enrolled, with emphasis on students from under represented subpopulations as well as those who may be struggling. Even those students who struggle in math and science during school can succeed on the job; with perseverance, many people who may have had difficulty with early math or science classes can later thrive in a STEM career. (STEMFlorida, 2012)

In addition, Florida used the research from the University of Chicago’s STEM School Study (S3) (2013) to help develop the state’s programs. According to S3 (2013), there were eight elements that make a STEM school: (a) problem-based learning, (b) rigorous curriculum, (c) school community and belonging, (d) career, technology and life skills were built in to the program, (e) personalization of learning, (f) external community support, (g) staff foundations were strong, and (h) essential factors like flexible staff who can be open to change that serve their community population without exclusion. Funded by the National Science Foundation, the S3 (2013) found commonalities in schools across the country using a questionnaire to summarize the findings. It found that schools that values STEM do not focus exclusively on the disciplines instead concentrated on instruction practices and culture of the school.

Interestingly, industry leaders of the state consider the lack of definition nationwide concerning. “*STEMFlorida* and its leaders consider this a crisis” (Davis, Grove, & Ross, 2012, p. 5). In their report, *STEM Index - Defining STEM for Florida: A Strategic Initiative of STEMFlorida, Inc.* (2012), they acknowledge the definitions of the leading STEM and labor research institutions, National Science Foundation, US

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Department of Labor (O*Net), US Immigration and Customs STEM Index, and the US Department of Commerce.

Georgia

Georgia's Department of Education has taken a proactive approach to STEM education addressing the competitive components, partnering with businesses, tackling the disparity of women and minorities, and providing grants to teachers and schools for STEM training and regional centers. The GADOE also justifies that STEM education is for all students, not just those with career aspirations related to STEM fields. For the state's definition, "In Georgia, STEM education is defined as an integrated curriculum (as opposed to science, technology, engineering, and mathematics taught in isolation) that is driven by problem solving, discovery, exploratory project/problem-based learning, and student-centered development of ideas and solutions" (Georgia Department of Education [GADOE], n.d.). Georgia offers STEM certification for schools and programs and has created rubrics for elementary, middle, and high school levels. The rubric was based on 15 separate criteria related to topics such as teacher preparedness and professional development, student work, integration of STEM fields, community partnerships, lab space, and targeted "non-traditional student participation" (GADOE, 2013, p. 1).

Hawaii

As the only state in the union with one school district, Hawaii appeared with a clearer message regarding practices and policy. STEM education in Hawaii has been defined with integration "through scientific inquiry and engineering design as unifying processes. STEM emphasizes innovation and the development of problem-solving, critical thinking and collaboration skills. Emphasizing arts creates engaging new

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pathways for learning” (Hawaii Department of Education [HIDOE], 2012). As part of Race to the Top, the definition was mandated through legislative action, HB 200 in 2011 (HIDOE, 2012). Regarding the STEM vision, Hawaii’s department of education has set forth five goals: (a) use integrative STEM, (b) increase the number of STEM teachers, (c) provide solid content in the four disciplines, (d) increase the number of students in STEM, especially for underrepresented minorities, and (e) nurture collaborative partnerships to improve greater access to STEM (HIDOE, 2012; HIDOE, n.d.-a; HIDOE, n.d.-b). Interestingly, graduates of Hawaii’s high schools can qualify for a STEM diploma through specialized coursework and meeting certain requirements.

Maryland

For Maryland policy, STEM education was defined in a very straightforward manner, “an approach to teaching and learning that integrates the content and skills of science, technology, engineering, and mathematics.” In defining STEM, MDSE *Is It the New Buzzword?* (2014) discounted the disciplinary approach and acknowledged the confusion related to the term, “It has so many meanings depending upon who is involved in the conversation.” In Maryland’s Vision Statement (2014), MSDE refers to “innovation, collaboration, and creative problem solving.”

In 2009, Maryland began the STEM Task Force to improve education initiatives linking them to the workforce. In 2010, Maryland was awarded Race to the Top funding by the federal government in phase 2. Enacted by Executive Order (Executive Order 01.01.2007.20) and implemented by Maryland Code 24-801, the P-20 Leadership Council of Maryland added STEM university representation in addition to other education advisors to address college and career readiness in education. Since December

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2014, they have been required to submit a report every two years. By 2014, equity became a focus for underrepresented groups; another objective was to improve the numbers of minorities in advanced placement STEM-related courses (Maryland Department of Education, 2014). Maryland's governor Martin O'Malley supported STEM as policy,

Ensuring that our students are prepared to compete in the economy of tomorrow is an important part of strengthening STEM education in Maryland. STEM programs offer our students the opportunity to broaden their skills, learn about new, cutting edge technology, and compete for jobs in fields such as technology, cyber security, and advanced manufacturing. Together, we will continue to provide our students with access to a high-quality education to ensure economic opportunity and strengthen and grow our middle class. (Office of the Governor, 2014)

In the state's P-20 Leadership Council Report (2009), Maryland repeatedly tied an integrated STEM to economic goals and addressed the access issue for underrepresented groups.

Massachusetts

The commonwealth set forth a STEM vision in the 52-page tome *A Foundation for the Future: Massachusetts' Plan for Excellence in STEM Education, Version 2.0: Expanding the Pipeline for All* (2013). Massachusetts had a five-pronged plan but no definition of STEM. The five parts included improving STEM interest, student achievement, number of STEM educators, percent of STEM graduates in certificate or higher education programs, and the alignment between STEM subjects and workforce fields (p. 4). The STEM Nexus - the network of STEM resources - acknowledged the confusing term:

STEM is currently an acronym without much depth. This often leads to multiple interpretations of what STEM means by different stakeholders.

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This working group will be reviewing the myriad of definitions of STEM that exist and recommend a definition of STEM for the Commonwealth to use, with the intention of defining the concept of STEM that will work for both educators and employers (Massachusetts Department of Higher Education [MASSDHE], n.d.).

An early adopter, the research and initiatives have been funded under the Massachusetts STEM Pipeline Fund since 2002 and administered by the Department of Higher Education for PK-16 programming. Called an “interest gap,” underrepresented minorities have also been a concern since the early version of the Pipeline (MASSDHE, 2016).

New York

STEM education policy in New York state has not been consistently defined. It runs the gamut for outcomes addressing higher education, occupational preparedness, teacher certification, after-school programs, women and minority participation.

The earliest use of STEM in NY state begins in December 2009, the NY State Professional Standards and Practices Board wanted to recruit teachers in mathematics, sciences, technology, and engineering and they offered support classroom supplies and equipment, reduced initial teaching load, mentoring for the new teacher; financial assistance, loan forgiveness programs, enhanced partnerships between education and STEM faculty for the higher education institutions. Regarding certification pathways, they also acknowledged the possibility of an interdisciplinary STEM certification model to enhance teacher recruitment and program development. Individual universities in NY offer elementary certifications with STEM endorsements (New York State Department of Education [NYSDOE], 2009).

Since 2015, NYS Higher Education has provided grants to cover the tuition for resident students who study STEM fields for SUNY (State University of New York) or

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CUNY (City University of New York) schools. They included a 37-page list of approved majors and posted an 11-page document that explained the occupations students might plan for with the program. Health-related occupations, such as nursing, medicine, or veterinary were excluded (New York State Higher Education Services Corporation, n.d.).

In the legislature, representatives addressed STEM initiatives. Individual representatives have shown that STEM should be part of state programs with varying success. Bill A968/S1960 (2014) was geared to supporting women and minorities in technology with support for STEM grants to develop 6-12 grade career exploration activities, and partnerships with post-secondary education and training programs for skill attainment. The bill required analysis of disadvantaged students who went to 2-year and 4-year STEM related programs or who worked for at least two years in STEM professions. Previous bill A6417 (2013) did not leave committee. Bill A968/S1960 (2013) was passed by both the Assembly and Senate, but was vetoed by the governor. Having never left the committee, for A8206 (2015) the sponsors used the phrase “science, computer science, technology, engineering, including design skills and practice, or mathematics” when elaborating on STEM in higher education, which also would have provided grants for undergraduates in STEM fields. A1507 (2015) and S6572 (2016) also never left committee, which had designed a pilot program for U-STEM, urban programs related to the four STEM disciplines. The bills proposed to provide tax credit for STEM-related business individuals to mentor students in urban schools but did not elaborate on STEM definitions beyond the four disciplines. The prior legislation was similar to A8366/S5934 (2014) that again did not leave committee. Earlier in 2011, joint resolution 1162 was passed commending Time Warner Cable for “Connect a Million

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Minds.” The interactive program is stated to have connected science standards to coding and STEM for middle school students.

In the *Statewide Strategic Plan for Science* (2015), STEM was defined as the four disciplines and the “connections between the disciplines,” which spoke of STEM education as integrated action.

North Carolina

Rather than serving up a definition, *North Carolina’s STEM Education Strategic Plan* (2011) offered several attributes for STEM education,

Beyond focusing on Science, Technology, Engineering, and Mathematics, STEM Education provides the opportunity to teach students what to do when they do not know what to do, how to process and take action in new and uncomfortable situations, and how to understand, interact, and lead in the jobs, communities, and world in which they live. (p. 7)

The stated attributes included (a) integrate STEM with state, national, international and industry standards, (b) engage with the community and industry in an on-going manner, and (c) include post secondary connections. The plan to develop STEM education in NC included being data driven along a student to workforce continuum, using such measures as 3rd grade math proficiency, 5th and 8th grade science proficiency, Algebra I completion, AP STEM course completion, STEM certificates and degrees, and number of STEM certified teachers. Another strategy involved STEM school creation using a rubric for appropriate grade levels (elementary, middle, high). Professional development for teachers was also part of the strategies to provide better STEM programs. The state of North Carolina also created a website devoted to the state’s STEM programs in education. According to NC’s *Strategic Plan* (2011), the website was designed purposely for community outreach. Tying it into the federal policy climate, the 2011 *NC STEM*

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Education Strategic Plan was formed to help align K-12 programs to K-20 with the *Career and College: Ready Set Go!* plan funded with Race to the Top financial support.

Ohio

Designed before Tennessee's Innovation Network's Internet hub and before Race to the Top, Ohio's STEM Learning Network has been supported by the Battelle Center and the Bill and Melinda Gates Foundation. It was devised as a joint program with public and private cooperation. According to the site, Governor Ted Strickland signed HB 119 in 2007 to allocate \$13 million to establish STEM schools and programs in Ohio. Several organizations Ohio's Department of Education, The Ohio State University and corporations have funded Ohio's overall STEM program (Ohio State Learning Network [OSLN], 2016). Using the STEMx network model, Ohio created seven STEM regions for program dissemination. Each region's training center and schools were developed in STEM practices. Regarding Ohio's definition, "STEM stands for science, technology, engineering and mathematics, but it is more than an acronym. While originally designed to encourage students to pursue careers in these areas, STEM education has evolved into a unique approach to teaching and learning that fosters creativity and innovative thinking in all students" (OSLN, 2016). STEM was, therefore, not for a select group of students but for all. Business and community partnerships were deemed important to Ohio's program. Beginning with a "platform school," Ohio aimed to:

1. Personal mastery of Ohio core subjects, information and communications technology literacy and 21st century skills...
2. Engage the power of science and mathematics as the international language of innovation and engineering and technology as the language of design.

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3. Learn how to create, acquire, analyze, synthesize, evaluate, understand and communicate knowledge and information in a global context.
4. Admission is non-selective with an emphasis on underrepresented and high-need student populations. (OSLN, p. 1, 2013)

Ohio even extended the STEM-ED definition across more disciplines than the traditional four, including social studies, language arts and foreign language. By September 2016, Ohio's STEM model of regional networks and platform schools spread to 21 other states, including Tennessee.

Pennsylvania

For PA, an integrative approach was used to describe STEM education.

According to the commonwealth's education department,

STEM education is an intentional, integrative approach to teaching and learning in science, technology, engineering, and mathematics. Students become adept problem solvers, innovators, and inventors who are self-reliant by asking questions, investigating, making informed decisions about how they live their daily lives and engage in their vocations and communities. (PDE, 2016)

The identical definition has appeared on both science and math curriculum pages of the PDE as maintained by Pa. Code, Title 22, Chapter 4. The technology curriculum page referred to STEM curriculum from the program materials Engineering by Design as the main framework for Pennsylvania's standards alignment. Like Ohio and Tennessee, Pennsylvania also joined the STEMx system, led by the Battelle Network and many other corporate. Called ASSET (Achieving Student Success through Excellence in Teaching), STEM in Pennsylvania piped through the ASSET organization to promote STEM services (ASSET, Inc., n.d.). Since 2014, Pennsylvania offered an Integrative STEM

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teaching endorsement through the department of education. I-STEM teachers were able to show off skills and competencies that promote the integrated definition model. While a teaching endorsement may show a commitment to STEM, neither the PDE nor ASSET, Inc. suggested that STEM education is a vehicle useful for equity. However, vocational and workforce alignment was mentioned by both to be part of a global economy.

Rhode Island

In the Race to the Top application (2010), RI acknowledged a lack of comprehensive “T&E” programming in STEM. Subsequently, it had developed Technology and Engineering grade span expectations in Rhode Island’s education standards. While Technology, Mathematics and Science have Governor’s Councils, as of 2016 the four disciplines were not yet integrated. In the 2010 RTTT application, Rhode Island encouraged the districts to align the four discipline’s standards, promoted project-based learning, and college and career readiness. “This deep understanding of the standards will enable Rhode Island educators to identify and embrace the cross-content application of STEM subjects and to convey the interconnectedness of content in these subject areas to their students” (p. 267). Offered as models, RI created a few charter schools with STEM focus and it celebrated the female-focused programs for middle and high school students: Girls Reaching Remarkable Levels TECH and Brown’s Women in Science and Engineering.

Since RTTT, Rhode Island has proffered a new acronym, STEAM, with Art + Design filling out the A. The state’s most well known university, RI School of Design, has managed to change to the policy conversation to STEAM and that true innovation

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that can come with combining the mind of a scientist or technologist with that of an artist or designer (RISD, 2016; STEM Center, 2016). The RI Senate Policy Office (2016) suggested that STEM/STEAM be leveraged in elementary and secondary schools, and certificate and degree programs to promote learning about green technology. The STEM Center of the Rhode Island College and 250 other individuals and groups have proposed a RI Governor's STEAM Council to promote and develop STEAM in P20 (STEM Center, 2015). The STEM Center had also proposed a name change to the STEAM Center to be reviewed in 2016 at the April meeting of the RI Board of Education (Council on Post Secondary Education, 2016).

While it has begun to focus on STEAM, the STEM Center (2016) has used the following definition on the webpage, adapted from the National Academy of Engineering and the National Research Council by Honey, Pearson, and Schweingruber (2014) STEM literacy:

- 1) Awareness of the roles of science, technology, engineering, and mathematics (STEM) in today's society
- 2) Familiarity with some of the fundamental concepts and knowledge underpinning each area
- 3) A basic level of application fluency, or in other words, application of STEM to one's own life and the ability to critically evaluate STEM content as it relates to contemporary issues.

When compared to other states, STEM policy could be considered in infancy for RI. The STEAM NOW Coalition (2015) has tried to influence the Governor. In his annual address to the General Assembly the Commission of Education Deborah Gist (2014) said, "With our world-renowned creative-arts culture, our history of innovation in manufacturing and design, and our growing 'maker movement' Rhode Island is the perfect home base for what has become a worldwide phenomenon." At a conference in

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2014, “Creating Future Capacity Building STE(A)M” the follow three topics were promoted by the commissioner at the time: “1) connecting engaged students to increase interest in STE[A]M; 2) connecting STE[A]M skills to increase career readiness; and 3) connecting statewide sectors to build on the wonderful work that is being accomplished in Rhode Island” (Gist, 2014). Additionally, in a joint memo from the Governor’s Office and the Commissioner of Education, they formed a working group to recruit and promote diversity in hard to staff fields, mainly STEM (Rhode Island Department of Education, 2015). Due to the multiple voices of STEM politics, Rhode Island has defined and not defined STEM successfully. It attempts the integrated definition (with Art) but has not gotten traction with the governor and the four domains do not join together in a cohesive way.

Phase 3

The next round of funding came about a year later in 2011. The states included Arizona, Colorado, Illinois, Kentucky, Louisiana, and New Jersey. The next group of states all received 100 percent for STEM, except Arizona, in the first round of funding (USDOE, 2010). By 2010, Arizona included STEM as one of the state’s major initiatives in the 3rd round application (Arizona Department of Education [AZED], 2011). Again, the following states have been listed and analyzed alphabetically.

Arizona

Based on Arizona’s RTTT application (2011), the state’s department of education valued service learning as an important part of the STEM program. Some of the goals were to increase field specific teachers, increase tech in rural areas and support the Science Foundation Arizona Stem initiative (SFAz STEM). Based on the following

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definition, Arizona has both STEM and STEM-ED. From SFaz's STEM Network (2014),

STEM education is an integrated, interdisciplinary approach to learning that provides hands-on and relevant learning experiences for students. STEM teaching and learning goes beyond the mere transfer of knowledge. It engages students and equips them with critical thinking, problem solving, creative and collaborative skills, and ultimately establishes connections between the school, work place, community and the global economy. STEM also helps students understand and apply math and science content, the foundations for success in college and careers.

As a non-profit, the SFaz began in 2006 and began integrating STEM in 2008 (SFaz, 2014). Since RTTT, SFaz developed an Immersion Guide for four stages of STEM in schools: Exploratory, Introductory, Partial Immersion, Full Immersion. The Department of Education's 21st Century Learning Center (2016), an afterschool model of increasing academics use for low income and minority students, has defined STEM as integrating at least two disciplines, reminiscent of the Vasquez, Sneider, and Comer (2013).

Interdisciplinary definition. The 21stCLC began STEM work in 2009 (ADE, 2016).

Since RTTT, Arizona offers a STEM teaching certificate for grades 6-12.

Arizona's department of education (2016) settled on the following definition on the website:

STEM literacy is the ability to apply an understanding of how the world works within and across the four areas of science, technology, engineering, and mathematics. It does not simply mean achieving literacy in these areas individually. STEM literacy, and beyond that, fluency, refers to the ability to investigate, question, and use these facets of the world in an interdisciplinary manner.

The ADE (2016) created a graphic that show the three sectors of creating STEM literate students: Teachers and School Leaders, Business and Industry, and Family and Community. An Arizona student should be "STEM literate, possess 21st Century

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literacies, interested and engaged in learning, able to make the connections among STEM disciplines and Arizona standards, and participate as active and responsible citizens.”

Except for the 21st Century Learning Center, the Immersion Guide and other supporting STEM materials do not appear to draw attention to minorities or female participation.

The Department of Education also has offered STEM teaching certificates and provided STEM Academic Standards to encourage and legitimize STEM (ADE, 2016).

Colorado

Like at least twenty other states, Colorado created an independent non-profit that works in conjunction with the state’s department of education. The Colorado Education Initiative promoted STEM education. Overall, the public-private partnership wished to make STEM exciting for more of the state’s students, “especially girls, low-income students, and minorities” (Colorado Education Initiative [CEI], 2014). CEI (2016) defined STEM as:

STEM competencies — often referred to as STEM literacy — prepare students to be critical thinkers, to persevere through failure to achieve success, to communicate and collaborate across real and perceived barriers, and to solve complex and ever-changing problems. Coloradans with these competencies will drive innovations and fuel our increasingly STEM-based economy

According to the *Colorado Talent for an Innovation Economy: Powered by STEM* (2014),

If Colorado...Builds community awareness and support for STEM, and fully coordinates and aligns STEM policies, practices, and partners to increase student interest, participation, and achievement in STEM; Focuses on ensuring all students achieve STEM literacy; Reduces its STEM talent and skills gap...then it will lead the nation in STEM talent development. (p. 2)

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In the state's RTTT application, Colorado linked the private workforce and career exploration for all students in the education programs. Specifically, the department of education adapted the following definition to explain the STEM program from Tsupros, Kohler, and Hallinen (2009),

An interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering and mathematics in context that make connections between school, community, work, and the global enterprise, enabling the development of STEM literacy and with it the ability to compete in the new economy. (CDE, 2016)

In addition, it supported STEM education with HB1243 (2007), HB1388 (2008), and SB185 (2009) in such endeavors including STEM after school pilot program for both middle schools and high schools, low-income and minority student achievement, STEM related majors for college, and career investment.

Overall, Colorado has used an integration definition for STEM. Included in the list of subject matter standards from the Department of Education's website,

STEM Education provides a venue for the transformation of teaching and learning by integrating content and the skills of science, technology, engineering and mathematics. Engaging students in 21st century practices through inquiry, critical thinking and reasoning, collaboration, invention, and information literacy through STEM education directly impacts their ability to succeed by mastering and transferring concepts within STEM disciplines and across all content areas. (CDE, 2015)

With an integrated STEM education words like collaboration, critical thinking, and transformation have been seen in other similar states' definitions.

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Illinois

While acknowledging other STEM models, the IL State Board of Education also used the Tsupro, Kohler, and Hallinen (2009) quote to define STEM. It also suggested that STEM be adapted using the following steps:

1) Select a central standard, 2) Align the standard with a relevant societal problem, 3) Support the lesson by matching with STEM standards, 4) Instruct according to the content standards, 5) Engage students in design and development of a solution to the problem, 6) Troubleshoot by identifying and correcting problems, 7) Evaluate by ensuring that students and teachers identify and fix the problem, and 8) (Students) Present the results. (Malin, 2014, p. 22)

The Tsupro et al. (2009) definition and Illinois' vision connected standards to real world learning with the incorporation of the design process from engineering. In the state's *Keeping Illinois Competitive* (2006) report attracting women and minorities was listed as the 14th priority. The Illinois Department of Education called it I-STEM. The acronym, has served to imply the integrated model, yet the "I" was also used to acknowledge the state's initial.

Kentucky

The first Kentucky Task Force for STEM began in 2006. To sustain the work of the task force, legislative action in 2008 produced Senate Bill 2 (KRS 164.0287). Committees were formed to promote awareness of STEM, work on professional development for K-12 and higher education, and work on partnership engagement. Both task forces stopped being active. In the Kentucky STEM Initiatives (2008) document, no clear definition was developed from the work; however, STEM was repeatedly tied to an

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increase in workforce participation, and better performance in math and science achievement.

Other groups have served Kentucky students with STEM. A private organization, Advance Kentucky (n.d.), promoted STEM achievement and underrepresented groups. The goals were to reach more students with advanced STEM subjects in high school. While it embraced the need for further research and action on STEM in schools to support a thriving STEM economy, the 2007 report, *Kentucky's STEM Imperative-Competing in the Global Economy*, STEM was not defined by Kentucky in *STEM Imperative* (2007). Finally, in addition to support the P20 education pipeline, Kentucky became another state part of the STEMx network with the Battelle Memorial Institute (University of Kentucky, n.d.). The KySTEMx (2016) tagline was listed as, “Transforming STEM education and workforce development *in* the states, *by* the states.” However, STEM was not defined by on the KySTEMx site like it did in many of the other STEMx partnerships.

Louisiana

With a lack of dedicated resources in STEM in Louisiana, independent, private stakeholders had taken it upon themselves to propose a similar program to Texas (T-STEM). On the L-STEM site, it referred to achievement in the STEM disciplines as the overall mission but did not define STEM. According to L-STEM (2016) has five aspirations: (a) Promote engagement and interest in STEM among all Louisianans; (b) Develop a statewide STEM bridge-network between industry, higher education, and K12; (c) Increase involvement of minorities, women and underrepresented groups in the STEM disciplines; (d) Increase opportunities for STEM enrichment and engagement at the

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middle and elementary levels; and (e) Increase access to quality STEM education across the state. (L-STEM Initiative, 2016). In addition, according to LA HCR No. 136 (2014), STEM was used as an acronym of the four disciplines. The goal was to encourage women and minorities in STEM fields.

New Jersey

Until 2016, New Jersey had limited STEM education presence for how it defined STEM. Instead the state focused on delivery of instruction, from the state's RTTT application (2010),

Our goals are to improve the delivery of higher-level content in the classroom, to provide more students in high-needs districts with access to challenging STEM coursework, to recruit more alternative-route qualified math and science teachers, and to subsequently provide more STEM career options for the students of New Jersey.

With the RTTT explanation, it would seem like it is a disciplinary definition of STEM education but it did not explain what STEM was in the application.

In the joint 2013 Assembly and Senate Bills (A2015, 2013; S2562, 2013), NJ introduced the term “non-traditional STEM programs.” According to the bills’ language “Non-traditional STEM teaching method” is a STEM methodology with “self-directed student learning, inquiry-based learning, cooperative learning in small groups, collaboration with mentors in the field of study, and participation in STEM-related competition.” (S2562, 2013). STEM was defined as the four fields with engineering “(including robotics)” (S2562, 2013). The bills were to fund a four-year grant program for the New Jersey Innovation Inspiration School Pilot Program for grades 9-12. (Additionally, Senate Bill S3094 in 2013 was geared toward K-8 but did not go beyond committee.) While the 9-12 program passed in both houses, Governor Chris Christie did

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not sign it according to the bills' histories. It was seen again in the Assembly in the 2014-2015 legislative schedule but did not get on the Assembly docket (A940, 2014). Likewise S960 (2014) did not pass beyond committee but it dealt with K-8 programs but practically identical to the other legislative action. Senate Bill 500 was introduced in January 2016 with the same language. In early 2016, identical legislation Senate Bill 1181 and Assembly Bill 2195 were proffered for grades 4-12 with the same STEM definitions and arguments.

Finally, only until the NJ DOE STEM Conference (2016) did NJ have its own working definition of STEM education. Developed from research from the National Research Council (2012) and with input from educators around the state in 2016 it reads as follows,

STEM Education is the use of science, technology, engineering, mathematics, and their associated practices, to create student-centered learning environment in which students investigate, engineer solutions to problems, and construct evidence based explanations of real-world phenomena. Evidence-based STEM education promotes creativity and innovation, while developing critical thinking, collaboration, and communication skills while students seek explanations about the natural world and improve the built world. (NJDOE, 2016)

Like many states, STEM education has evolving definitions that changed even during the research of this study.

Not Awarded Race to the Top Funding

The following states listed below alphabetically all applied in the initial funding cycle but did not receive Race to the Top financial support in any phase. Eight states received zero credit for STEM competitive funding including West Virginia, Oklahoma, Missouri, Wyoming, Kansas, California, Connecticut, and Indiana (USDOE, 2010).

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Politics of federal policy warring with state priorities were evident with one state in particular. South Carolina scored in the top ten during the first round of applications but dropped out of the Race to the Top application competition. The first application was under Democratic State Superintendent Jim Rex in 2010. By 2011, Republican State Superintendent Mick Zais had taken South Carolina out of the running. Both superintendents, however, stated they did not like the “silver strings” or conditions attached to federal application (Smith, 2011). With a sixth place finish, the likelihood of a phase 3 funding cycle would have been high, however, South Carolina remained without funding from the federal government.

Alabama

Alabama State Department of Education created the Alabama Math, Science, and Technology Initiative (AMSTI) under the Division of Teaching & Learning to improve math and science education opportunities for all students in grades K-12. According to the mission, the state promoted knowledge and skills for the workplace and/or college studies (AMSTI, 2000). Using professional development as the method of dissemination, AMSTI focused on strategies that address the diverse needs of students and incorporate purposeful, hands-on, inquiry-based instruction as well as active engagement in problem solving, reasoning, and investigation. There was no mention of engineering principles or design thinking with AMSTI, however, RTTT addresses engineering and women with support of GEMS-U, and encouragement of Project Lead the Way, an integrative STEM curriculum in 27 of the state’s schools (AMSTI, 2000). Even in one of AMSTI’s latest publications, engineering is left out of the disciplines; “Students in AMSTI Schools learn math, science, and technology through activity-based, inquiry approaches consistent with

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the latest research on effective math and science instruction” (Alabama State Department of Education, 2015).

Arkansas

Arkansas’s RTTT application would like all of the state’s students to build upon their STEM programs. The state used the Educators in Industry model to promote workforce and careers development. In the state’s RTTT application, STEM was also to help under represented groups and increase the number of Advanced Placement programs. In 2011, AK governor established a pilot to improve STEM education at the high school and university level. The program, STEM Works, has a stated aim to increase the number of qualified STEM teachers and to improve the ways all students receive STEM education. Arkansas has used U-Teach, Project Lead the Way and EAST Core to meet these goals. Finally, while driven by economic goals, STEM was not defined by the STEM Works delivery system (ADE, 2014).

In addition, the Arkansas Economic Development Commission for Science & Technology support has supported STEM education initiatives. “The ASTA STEM Education office serves a key function in coordinating statewide initiatives that support the training and preparation of Arkansas students for the needs of the 21st century science, technology, engineering and mathematics workforce” (AEDC, 2015). Yet STEM was not defined beyond the four disciplines.

Lastly with the Arkansas’ CTE pages, STEM has been deemed important because, “STEM courses prepare students for high-skills, high-wage, high-demand careers. STEM nurtures students to become creative problem-solvers, innovators, and inventors; analytical thinkers; and strong communicators” (Alaska Department of

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Education [AKDOE], 2012). Using the CTE terminology, STEM was defined, therefore, as the catalyst not a philosophy.

California

Since 2012, California created a task force to continue STEM efforts. In the state's definition of the STEM discipline model, it linked STEM in schools to career building skills. "Through STEM education, students learn to become problem solvers, innovators, creators, and collaborators and go on to fill the critical pipeline of engineers, scientists, and innovators so essential to the future of California and the nation" (California Department of Education, 2015). In California, STEM was seen as an opportunity to improve skills and raise student achievement for the four disciplines. Yet, "The most effective STEM education takes place where expanded, informal learning, and K-12 regular day instruction are integrated and the unique potential of each of these environments is fully leveraged for high-quality STEM education, often referred to as STEM ecosystems" (California Department of Education, 2015). California has expanded definitions of the four disciplines, which ultimately integrated into each other.

In *Innovate: A Blueprint for STEM* (2014), California Department of Education laid out the state's weaknesses in STEM education and acknowledged that science and mathematics were the primary focus in K-12 schools till the present, "Technology and engineering have not been prominent in the curriculum" (p. 8). California associated both educational goals and workforce goals with STEM priorities. In *Innovate* (2014), California also acknowledged it has not met the needs of underrepresented groups like women, African Americans and Latinos in STEM, whether based on equal access to high quality STEM education, professional development for the state's teachers, unbalanced

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programs in the STEM disciplines, or lack of caliber hands-on opportunities for students. Another opportunity was to build the state's Career and Technical Education (CTE) programs, to improve competencies and skills to enter the workforce.

To meet STEM objectives, in the state's RTTT application and in *Innovate* (2014), California suggested it will improve its K-12 regular learning opportunities during the school day, increase expanded learning after school or during the summer months, and provide informal learning in libraries, museums, and parks. Informal learning also provides experiences for parents and educators (professional development).

Connecticut

In Connecticut's RTTT application, STEM was not clearly defined. It listed STEM resources - museums, institutions, and partnerships - to foster STEM in the state. It mentioned that CT has increased the state's requirements for graduation with STEM courses in high school. Connecticut's application focused on increasing student participation in AP courses and technology usage, and suggested that STEM professional development should be a priority for the state's teachers. The application did set forth increasing minority participation in STEM classes as one of the department's goals and using after school programs to increase participation (Connecticut State Department of Education [CT DOE], 2010). Furthermore, CT, like other states, has a Mathematics and Science Partnership Program (MSP) to improve standards-based pedagogy for teachers and to raise student achievement for all, in particular for populations underserved (CSDE, 2105). Overall, STEM did not appear in the forefront of the department of education. Beyond the MSP, it did not feature a website related to STEM itself nor STEM goals for the state.

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Idaho

The State Board of Education has recognized the critical need to ensure Idaho has a thriving STEM education pipeline. Through its P-20 Strategic Plan 2014-2018 (2014) it stated that a “diverse citizenry” must have the skills and knowledge about STEM for “critical and creative thinking, problem solving, innovation and collaboration.” STEM was geared for all students through primary to university. To support the goals, Idaho has a STEM Action Center supported by the state government. The Action Center was created in 2015 by HB 302 and supported by code §67-823. Unfortunately, no definition of STEM existed clearly on the supporting materials.

Indiana

In the Indiana Department of Education’s STEM Initiative Plan (2012), the following definition by Rider-Bertrand (2007) was used,

STEM education is an intentional, metadisciplinary approach to teaching and learning, in which students uncover and acquire a cohesive set of concepts, competencies, and dispositions of science, technology, engineering, and mathematics that they transfer and apply in both academic and real-world contexts, in order to be globally competitive in the 21st Century. (p. 1)

In addition to the department’s work, Indiana has used the work of another state to guide the STEM work. Arizona’s Science Foundation helped Indiana formulate the state’s goals. Like many of the other states in the union, Indiana has a stated belief that STEM was for all and that the academic and career preparation in the schools helped the United States be “on par” with other competitive countries. Beyond the integrative definition, Indiana also has suggested that STEM class was “non-traditional...questioning the interrelated facets of the real world.” Along with promoting STEM businesses and

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increasing STEM knowledge, according to Indiana, underrepresented minorities also should be part of the state's STEM vision. Indiana has also composed a four-stage implementation matrix for public schools. In 2015, Indiana Department of Education awarded the state's first school STEM certification (IDE, 2016).

Iowa

Just like several other states, Iowa also has cited Tsupros, Kohler, and Hallinen (2009) for an interdisciplinary STEM definition. However, when defining the acronym STEM, Iowa has a unique philosophical interpretation and goes beyond just listing the four disciplines. For science, it was the "Study of the nature of the universe." For technology, "Applying information to the design of goods and services." For engineering, "Application of knowledge for the benefit of humanity." And for mathematics, it was the "Universal language of nature." Iowa's initiatives have been promoted by the Governor's STEM Advisory Council "dedicated to building a strong STEM education foundation for all Iowans" (Governor's STEM Advisory Council, 2015). It tied STEM into economic impact with the catchphrase, "Greatness STEMs from Iowans." Even though in the Advisory Council's 2013 presentation for STEM initiatives that recognized the small number of minority groups in STEM, underserved populations did not appear to have continued through with its action plan (Governor's STEM Advisory Council, 2013). While it had 15 active working committees, no committee was tied into underrepresented STEM participants. Based on the language of the state's STEM website, STEM was to be promoted for all students to build a STEM workforce (Governor's STEM Advisory Council, 2015).

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Kansas

After investigating STEM in most of the country, Kansas has appeared unique but without a cohesive vision for STEM education. With the University of Kansas and funding with Noyce Foundation, Kansas has created an enrichment model for STEM (University of Kansas School of Education, n.d). It hopes to improve informal STEM education for more students. It has a STEM teaching license for high school related to the disciplines but not for integrated STEM. It appears to be promoting STEM as the four disciplines (Kansas State Department of Education [KSDE], 2016). None of these sources define STEM.

For Kansas, STEM was also part of the traditional CTE programs. Not surprisingly, STEM CTE was geared toward making more STEM professionals in the related disciplines (KSDE, 2016).

Michigan

The Michigan STEM Partnership, another STEMx state, has used the definition from LiveScience, and considered to represent the four disciplines, “STEM education, therefore, refers to an education initiative that addresses quality and participation in these disciplines out of economic, political, and educational concerns” (Michigan STEM Partnership, 2016). However, a STEM curriculum in schools is interdisciplinary, STEM is a curriculum that takes an interdisciplinary and applied approach to teaching science, technology, engineering, and mathematics. Rather than teaching those disciplines as separate and independent subjects, STEM combines them into a cohesive learning paradigm based on real-world applications” (Michigan STEM Partnership, 2016). Therefore, both definitions have been used on Michigan’s own STEM materials.

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In 2015, the MI Board of Education supported the MI STEM Partnership with grant money and support. The BOE's goals:

The target populations are organizations conducting student-focused, project-based programs and competitions, either in the classroom or extracurricular, in science, technology, engineering, and mathematics subjects such as, but not limited to, robotics, coding, and design-build-test projects for schools with achievement gaps from pre-kindergarten through college level (State of Michigan Department of Education, 2015).

With the above quotation, Michigan has a comprehensive vision for STEM in all levels of public education, in school or out.

Minnesota

State standards in science, mathematics, technical literacy, and language arts were “intentionally” linked to support STEM education. In Minnesota,

STEM education provides intentionally designed and linked learning experiences for students to develop and apply understandings of science, technology, engineering, and mathematics concepts and processes. Integrated STEM education exemplifies standards-based, best practice instruction from each field to explore relevant questions and problems based in the natural and designed world. (Minnesota Department of Education [MDE], 2015)

The Minnesota definition has links to other state definitions, including New Jersey, highlighting real problems in the world outside of the classroom.

Minnesota uses *getSTEM* to combine the state's resources. Partners have included Thomson Reuters, Avtex, Ecolab and the Minnesota Department of Education, *getSTEM* has stated that STEM was “economic currency” and students need to be prepared to be employable in the economy (*getSTEM*, n.d.).

Unfortunately, overall goals and implementation were not apparent on the Minnesota documents except for the following statement: “The Minnesota Department of

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Education supports STEM achievement for all learners by providing guidance and technical assistance on implementation of academic standards, current literacy best practices, multi-tiered systems of intervention, and STEM policy administration” (MDE, 2015).

Missouri

In the state’s literature, Missouri supported STEM as part of the global economy and supporting an educated citizenry. Missouri’s Department of Higher Education partnered with the Math and Science Coalition, which received support from the state’s Chamber of Commerce. The state has created eMINTS (Enhancing Missouri’s Instructional Networked Teaching Strategies) to support professional development to improve STEM in the state. One of eMINTS strategies has been to partner with the Missouri After School Network (MASN) (2016) to improve informal STEM opportunities with Project Liftoff. In addition, Missouri has nearly 400 schools using Project Lead the Way to encourage STEM in schools (Office of Missouri Governor Jay Nixon, 2015). Unfortunately a comprehensive definition did not materialize on the numerous Missouri websites, directories, or papers. Interestingly, in paper the MO Department of Elementary and Secondary Education used wholesale, *A STEM Call to Action: The Overlooked STEM Imperatives (2010)*, technology and engineering were the focus and defined as separate terms. In the nine-page glossary of the Missouri Program Planning Handbook (n.d.), STEM was not a term.

Nebraska

Searching STEM education in Nebraska turned up several results for afterschool education, 21st Century Community Learning Centers, lists of STEM resources and links

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to university websites. For example, from the University of Nebraska Omaha's College of Education,

STEM is really, at its heart, about problems and solving problems. How do we bring different disciplines together so that the problem is solved, it's better understood, and then others can learn from what we do in order to solve those problems? So when we do STEM, we're really modeling what's happening in the professions today. (Net Nebraska, 2013)

The state's public broadcasting network featured The State of Education in Nebraska with STEM as the state's repeated focus in 2013. Experts may define STEM but did it wind up in policy? Apparently it did not. Like other states, STEM was not defined comprehensively except in piecemeal fashion dealing with implementation. One example was listed with career and technical education. In contrast to more catchall definitions, according to the Nebraska Career Education (n.d), STEM "Learners who pursue this cluster will be involved in planning, managing, and providing scientific research and professional and technical services including laboratory testing services, and research and development services." Nebraska also did not address whether STEM education was for all or how it serves the economy or minority populations.

Nevada

Nevada's legislature passed Senate Bill 345 (2013) to begin an advisory council for STEM. The Nevada STEM Advisory Council (2015) adopted the following definition:

STEM (Science, Technology, Engineering, and Mathematics) education focuses on active teaching and learning, centered on relevant experiences, problem-solving, and critical thinking processes...STEM education emphasizes the natural interconnectedness of science, technology, engineering, and mathematics, and their connection to other disciplines, to produce informed citizens that possess and apply the necessary

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understandings to expand Nevada’s STEM-capable workforce in order to compete in a global society.

The Brookings Institute’s policy report, *Cracking the Code on STEM: A People Strategy for Nevada’s Economy* (2014), has been critical of Nevada’s lack of comprehensive STEM education policy. “The council’s ability to promote and expand high-quality STEM education in the state remains in question” (Brookings Metropolitan Policy Program, 2014, p. 1). Another piece from a Nevada State Board of Education member was critical of Nevada’s STEM policies, or lack thereof, “There is no path to economic diversification that does not require improvement in STEM education” (Newburn, 2015). The Nevada STEM Advisory Council did not have to publish a full report of the meetings until 2017. Compared to other states in the union, Nevada considered itself to be behind in STEM education policy objectives.

New Hampshire

The New Hampshire Governor’s Task Force on K-12 STEM Education (2015) used California’s *Innovate* (2014) blueprint of STEM to develop a definition. According to the Task Force, “STEM K-12 education is the study of science, technology, engineering, and math as separate subjects and together. Most STEM educators believe that STEM is best taught by exposure to core concepts and theories through learning by doing” (Governor’s Task Force on K-12 STEM Education, 2015). In New Hampshire’s report, *Pathways to STEM Excellence: Inspiring Students, Empowering Teachers and Raising Standards* (2015), New Hampshire has a stated goal for all students to become STEM literate,

...in order to be able to effectively engage in a rapidly changing world with a better understanding of science, technology, engineering and

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mathematics. STEM literacy will enable students to become strong contributors and successful citizens. Some will aspire to be part of the next generation of scientists, inventors, technicians and developers of new theories and solve the many complex problems we face to make New Hampshire a better place to live. (p. 16)

Some of the ways NH planned on implementing STEM literacy include increasing the number of students in advanced courses, adding the number of girls engaged in STEM activities, and assisting in developing professional learning opportunities.

New Mexico

New Mexico's Public Education Department has a STEM webpage, which featured a collection of sites from the state focused on STEM. One site was for the Math and Science Advisory Council, which was instituted from Senate Bill 552 and statute 22-15E-1 NMSA 1978 (2007), also known as "The Math and Science Education Act." Every year, the Council issued an annual report. In 2013 and 2014 the report was called, *Creating Roots for STEM*. In 2015, it was renamed *STEM Ready*. New Mexico has been concerned with the math and science performance of minority subgroups, particularly for Hispanics and American Indians who comprise 70 percent of the population (New Mexico Math and Science Advisory Council, 2015). In the latest report, it acknowledged a need for a vision for STEM education for all citizens to improve the state's workforce. Some of the methods it recognized as part of the plan included improving teacher skills and using afterschool activities to support STEM. In the glossary, STEM was defined as the simple acronym, which was not surprising due to the New Mexico's two discipline advisory council.

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North Dakota

Like RI, North Dakota included Arts as part of the definition. STEAM education, therefore, was defined as an “integrated curriculum (as opposed to science, technology, engineering, arts, and mathematics taught in isolation) that has been driven by creative thinking, problem solving, discovery, exploratory project/problem-based learning, and student-centered development of ideas and solutions” (North Dakota Department of Public Instruction, n.d.). The first of the state’s main goals were to go after funding opportunities to improve STEM education and to change the organizational system of Carnegie Units to master of material. Secondly, ND PDI wished to increase graduation rates and the number of graduates who go on to STEM degrees and careers. The 2013 House Bill 1228 appropriated \$160,000 for two years to begin the ND STEM Network (North Dakota STEM, 2016). While not part of STEMx, the infrastructure of business and education partnerships appeared similar. The design of the program even had regional support networks that were a unique component of STEMx.

Oklahoma

Oklahoma’s Department of Education acknowledged that STEM was considered beyond the disciplinary acronym but harder to define, “STEM is an acronym for Science, Technology, Engineering and Mathematics, but it’s not something that can be simply defined. To truly understand non-superficial STEM education, the idea of perspective and a variety of innovative instructional practices must be considered” (Oklahoma State Department of Education, 2015). To follow through on the STEM vision, OK education has been designed around three goals: “(1) Ensure all students have access to STEM education opportunities; (2) Ensure all students have access to highly effective STEM

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educators; and (3) Leverage the stakeholder resources and partnerships to strengthen the STEM education effort of each school.” Overall, OK measures STEM readiness of the state’s graduates, that all have access to STEM and that the teacher pipeline to STEM fields must be strengthened. Specifics to minority populations were not mentioned in *STEM Strategic Report for a STEM State of Mind in Oklahoma* (2013).

Oregon

In Oregon, the connections between the disciplines were apparent in the state’s STEM definition,

An approach to teaching and lifelong learning that emphasizes the natural interconnectedness of the four separate STEM disciplines. The connections are made explicit through collaboration between educators resulting in real and appropriate context built into instruction, curriculum, and assessment. The common element of problem solving was emphasized across all STEM disciplines allowing students to discover, explore, and apply critical thinking skills as they learn. (Oregon Department of Education, 2016)

Oregon also lists three outcomes: (a) improving student academic performance in STEM subjects; (b) increasing access and interest for those to pursue STEM careers; and (c) “Becoming proficient in STEM concepts necessary to make personal and societal decisions” (STEM Education Initiative, 2013). The framework did not mention minorities but emphasizes STEM for all. Oregon was also part of STEMx.

South Carolina

South Carolina was one of three states to include art concepts involving STEM education. According to South Carolina’s website from the department of education (2016),

The goal of STEM and STEAM related professional learning is to support teachers with pedagogical-content knowledge that translates into effective

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classroom practices which integrates the four domains of science, technology, engineering and mathematics. As a result, students in effective STEM and STEAM classrooms learn how to identify, apply and integrate concepts from those four domains in order to understand complex problems and to solve problems using innovative approaches.

While the state has used the term STEAM it did not list Art as one of the disciplines. STEM/STEAM were listed under the Standards and Learning section of the education department's website. However, the only resource listed was for the International Society for Technology Education (ISTE) standards. One of its STEM Initiatives was to recruit teachers in STEM. In 2009, it began outreach for science and mathematics but expanded to STEM with a grant from the National Science Foundation. Another STEMx partner, Solutions in Science, Technology, Engineering and Mathematics (STEM) Centers SC has been managed by the state's math and science coalition. S²TEM's stated purpose was to "serve South Carolina by growing the Science, Technology, Engineering and Mathematics (STEM) possibilities and capabilities of learners and leaders." As with most STEMx partnerships, there was no mention of minority participation increases.

South Dakota

As with other states without a defined STEM initiative, STEM falls to CTE programming. Such was the case for South Dakota, which uses the following Career Cluster definition, "Planning, managing, and providing scientific research and professional and technical services (e.g., physical science, social science, engineering) including laboratory and testing services, and research and development services" (South Dakota Department of Education [SD DOE], 2016).

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STEM education was mentioned in other avenues across the state. The First Lady of South Dakota, Linda Daugaard, promoted STEM literacy on her website, particularly to encourage health care training. The SD State University has an Institute for STEM Education Enhancement to promote STEM teaching. It has six goals: (a) advocacy, (b) recruitment, (c) collaboration, (d) promote education opportunities, (e) research, (f) acquire more resources to facilitate goals (South Dakota State University, 2016). Another group, the SD Innovation Lab, independently operated through grants, works with rural schools and American Indian reservations to bring STEM resources to the local communities. They use the transdisciplinary problem-based learning approach to STEM, “collectively views “STEM” as a mindset that embraces the engineering design cycle and/or scientific method as the foundation of our teaching and learning strategies” (South Dakota Innovations Lab, 2016). In 2010, the state’s Race to the Top application was geared toward reaching the American Indian population with STEM (SD DOE, 2010).

Utah

Utah began a STEM Action Center with bills HB 139 (2013) and HB 150 (2014) and code U.C.A. 63M-1-3201–3211. While Utah did not appear to define STEM beyond the acronym, the state’s Action Center did have a stated mission to improve education, linking it to economic prosperity. The STEM Action Center included two goals for the vision include: “1) Produce a STEM-competitive workforce to ensure Utah’s continued economic success in the global marketplace, and 2) Catalyze student experience, community engagement and industry alignment by identifying and implementing the public- and higher-education best practices that will transform workforce development.” Some the methods used to approach the vision include increasing the number of teachers,

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highlighting STEM corporations, creating STEM designations for schools, and offering grants directly to students and teachers. While economic imperative and overall student engagement were clearly listed, other aspirations involving minority participation were not.

Virginia

In Virginia, STEM, like many other states, has provided resources under the auspices of Career and Technical Education. Twenty-three Governor's STEM Academies had been established to foster STEM education. On the website, according to the philosophy behind the academies,

STEM literacy is an interdisciplinary area of study that bridges the four areas of science, technology, engineering and mathematics. STEM literacy does not simply mean achieving literacy in the individual strands. STEM classrooms shift students toward investigating and questioning the interrelated facets of the world. (Virginia Department of Education, 2016)

The academies combined traditional academics and CTE to encourage more students in career preparation. The commonwealth's program began in 2007 after receiving money from the National Governors Association.

West Virginia

For West Virginia, STEM initiatives began with earnest in 2014. Executive order number 3-14 in April 2014, by Governor Earl Ray Tomblin, established the WV Council on STEM. The report that came from the Council did not define STEM. However, the state had three recommendations to follow in improving STEM: (a) establish regional hubs, (b) promote an awareness campaign for economic development, and (c) develop the current STEM resources in the state. (West Virginia Council on STEM, 2014).

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By 2016, West Virginia joined the STEMx network run locally by West Virginia University. They used the Tsupros, et al. (2009) definition seen with several other states. In addition, “We also intend to impact science literacy so that more of our citizens can fully participate in today's democratic process” (West Virginia University, 2016). It included in the network’s aspirations to increase STEM for all and to increase the number of STEM professionals.

Wisconsin

Just like Colorado and Iowa, “Wisconsin STEM,” a program initiative by the University of Wisconsin, used Tsupros, Kohler, and Hallinen (2009) on the state’s homepage to define STEM. Wisconsin acknowledged the STEM pipeline through schools and industry has been inadequate to meet the needs of economic development. From the Department of Public Instruction, STEM was also clearly laid out. Included as the department’s goals on the DPI website:

STEM Education in Wisconsin should: 1) Actively invite, engage, motivate, and inspire all students in these subject areas and related career pathways; 2) Raise the achievement of all students so that they are prepared to create and use technology in their learning, college, community, and careers; 3) Close the achievement and technical skill gaps between economically disadvantaged students, ELLs, students of color, and their peers; 4) Increase the number and diversity of students who aspire and succeed at the highest levels of academic and technical achievement in these subject areas and related career pathways; 5) Inspire learning which benefits the common good, resulting not only in individual gains in STEM skills, but also in stronger communities as a result of students applying their skills to solve relevant community issues. (Wisconsin Department of Public Instruction, 2016)

Wisconsin had a clear vision of what STEM should be in the state linking career trajectory, STEM for all but also focused on at risk populations, and involving

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community partners. It has produced resources for students, parents and teachers that can be easy to understand what STEM was considered and what it should be in the classroom.

Wyoming

While Wyoming did submit a RTTT application for the first round, it did not for the next round, and therefore, moved on to finding other funding sources for STEM initiatives. In 2012, the state held a summit with representatives from P-16 to discuss STEM and CTE programs (Wyoming Department of Education, 2016). From the initial meeting, an online network was formed to create a database and strategy for STEM programming. The University of Wyoming, the department of education, and other schools and businesses from the state created WYSTEM. On the website it did not define STEM beyond spelling out the acronym but did link STEM to CTE, after school programming, and the workforce pipeline (WYSTEM, n.d.).

STEM Education Definitions Without Race to The Top Applications

The following ten states did not apply to Race to the Top in the initial round. Four states never applied for the grants: Alaska, North Dakota, Texas, and Vermont. STEM definitions were found by using other materials including bills, executive orders, state-sponsored websites, and press releases from legislative or executive branches.

Alaska

For the Department of Labor, Alaska has acknowledged definitions of STEM from several agencies: Advance CTE (formerly known as the National Association of State Directors of Career Technical Education Consortium (NASDCTEc), National Research Council, National Science Foundation, National Governor's Association, and

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the California Department of Education. While a labor organization, Alaska's DoL highlighted school programs across the state in its Overview of Science, Technology, Engineering, and Mathematics presentation by the Workforce Investment Board (2012). The presentation used definitions that reflect the interdisciplinary approach to cumulative occupational categories, in doing so Alaska has highlighted the dilemma this researcher has faced. The Alaska Workforce Investment Board has, therefore, not recognized one definition over others.

The Juneau Economic Development Council commissioned a report, *Alaska S.T.E.M.: Education and the Economy* in 2012 that explained the state's initiatives and lack of cohesive policy. The JEDC defined STEM with familiar terms like interdisciplinary, real-world, problem solving, teaching through discovery, for all students. It analyzed the CTE model and believed that the STEM project based methodology should be part of the education program for all students. The analysis acknowledged that Alaska had pockets of STEM but not an organizational structure linking the programs in the state.

In recent funding, Alaska has authorized a STEM pilot academy program in high school and middle school (2014). With HB 278, Alaska's Educational Opportunity Act (2014), two non-profit organizations align to schools with disadvantaged students to assist in establishing STEM programming. The partners, Alaska Native Science and Engineering Program (ANSEP) and the Southeast Regional Resource Center (SERRC), were awarded funds to set up summer academies for students, after school programs, and assist with career exploration.

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Beginning in 2015, Alaska’s Department of Education and Early Development provided grants for 21st Century Community Learning Centers for after school activities not found in the school day. According to the 2014 Request for Applications guide, one way to receive funds was to establish “STEM project-based” activities.

Maine

While they did not apply for RTTT with a STEM application, the state has written a clear plan for STEM education. Maine’s Department of Education released the *Statewide Strategic Plan for Science, Technology, Engineering, and Mathematics (STEM)* in 2010. They addressed three issues with their plan and defined STEM reflecting inclusion, integration, and career pathways.

Science, technology, engineering and mathematics are the foundations of an advanced society. Federal and state leaders and the academic community view the strength of the STEM workforce as an indicator of our ability to sustain ourselves. If we wish to ensure equitable access to high wage, high growth employment for Maine students learning in these areas must also be part of the educational foundation for all Maine students. (Maine Department of Education, 2010, brochure)

More recently, Maine published *The Maine STEM Education and Workforce Plan 1.0* based on the 2011 law (LD 1540, HP 490) expecting each person in Maine be “clear and effective communicator, self-directed and lifelong learner, creative and practical problem solver, responsible and involved citizen, and an integrative and informed thinker” (Maine STEM Council, 2014). They aimed for a program in prekindergarten through university to increase minority participation, improve economic development, and knowledge in STEM fields.

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Mississippi

Mississippi Department of Education did not define STEM in its documentation. As part of its *2016-2020 Five Year Strategic Plan* (n.d.), Mississippi Board of Education has posted a goal so that every student shall graduate high school to be ready for college and career. One of the goal's outcomes was listed as, "Increase the number of schools offering and students passing advanced STEM-pathway courses in high school." STEM-pathway courses were considered another way of talking about the separate courses in science, technology, engineering and mathematics. However, no documentation or evidence was included in its strategic plan to further explain how to define and implement STEM in the state.

Other STEM happenings, however, occurred in Mississippi. In May 2015, Mississippi Department of Education (MDE) approved Mississippi College, a private higher education institution, to be the first school in the state to issue K-12 STEM teaching endorsement. In its application for approval, they wish teachers to "practice model-based reasoning and inquiry" and "facilitate creative and innovative thinking about the natural world and how to challenge our students to solve real-world problems through constructive, project-based activities and modeling processes" (MDE, 2015). Pre-service teachers would study technology literacy, the design process, emerging technology, CAD (Computer-Aided Design), sustainable technology, power and energy, robotics, and 21st century workplace skills. These programs offer integrated STEM-ED curricular models (MDE, 2015). While Mississippi College mentioned career outcomes and integrated coursework, it did not refer to increased access for minority groups as one of its goals (Mississippi College, 2015).

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Based upon what was being supported at the collegiate level, there were probably STEM programs in Mississippi in traditional K-12 schools. Unfortunately, a search of Mississippi legislative databases, press releases, and other documents produced scant evidence for STEM whether integrated or not. The MDE, however, supported a school dedicated to the gifted for science and math. The Mississippi School for Mathematics and Science was considered a public, residential program for gifted students on the campus of Mississippi University of Women. The Miss. School for Mathematics and Science website did not feature STEM definitions and the coursework promotes an Advanced Placement program and listed numerous science and mathematics courses.

Montana

In 2011, Montana established the STEM Initiative. On the state's website, Statement of Purpose and Definition (2011), Montana described STEM as "a way of thinking that values the particular perspective of thinking and learning embedded in each discipline, and also encourages the integration of strategies and core content from all four disciplines." The definition also suggested that STEM causes Montana residents "to be informed citizens, be stewards of the state's natural resources, improve our social and economic conditions, and compete in the local and global economy" (Juneau, 2011).

Since 2015, STEM education in MT was supported by an annual scholarship fund legislated by the government (HB 617), which diverted funds from its lottery appropriations. It will annually recognize students by their desire to continue with STEM majors and careers, including the health sciences.

The Governor's Office of Economic Development has supported STEM education initiatives. It claimed that the state is ninth in STEM job growth (MT

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Governor's OED, n.d.). Like other states, Montana also used the Mathematics and Science Partnership to continue the work related to the fields and integration regarding STEM initiatives (Miller & Cobbs, 2012).

While it initially did not have women and minorities in mind when fulfilling the STEM initiative kickoff in 2011, by 2014 the state encouraged STEM mentors to guide young women in STEM fields since it was an underrepresented field. "Through the Montana STEM Mentors initiative, we'll build on the knowledge of these men and women to open new doors of opportunity for the next generation," said Lt. Governor McLean in a press release (Office of the Governor, 2014).

Texas

In 2011-2012, the Texas Education Agency teamed up with universities and corporate foundations from National Instruments, Bill and Melinda Gates Foundation, etc. to form a private-public partnership for the Texas Science, Technology, Engineering and Mathematics Initiative (T-STEM). They now have 70 T-STEM programs serving over 40,000 students across the state (Educate Texas, 2016; Texas Education Agency [TEA], 2016). T-STEM focused on 6-12 education programs that meet benchmarks in teacher professional development needs, student outreach, and curriculum. To explain T-STEM,

T-STEM Academies are rigorous secondary schools focusing on improving instruction and academic performance in science and mathematics-related subjects and increasing the number of students who study and enter STEM careers...showcase innovative instruction methods which integrate technology and engineering into science and mathematics instruction. (TEA, 2016)

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Reminiscent of Iowa's definition, STEM was defined in its *Texas STEM Blueprint* (2010), "1) Science - Using inquiry, materials testing, data collection; 2) Technology - intake, processing, output (communications); 3) Engineering - engineering design process in projects, problem solving, innovation; and 4) Mathematics— symbolic language, analysis, trends" (p. 40).

Texas began STEM programming through Governor Rick Perry's Executive Order, which authorized funds for college and career readiness and accountability (RP53, 2005). The *T-STEM Blueprint* was initially written in 2005, updated in 2008, and in 2010 added rubrics and glossary. It acknowledged the tie to economic goals, university partnerships, and professional development for teachers at the secondary level. While it defined "underrepresented students" in the *Blueprints Glossary*, no other mention related to the benchmarks, strategic vision, or plan for T-STEM appeared in the defining document.

Vermont

Vermont used the Mathematics and Science Partnership (MSP) Program as part of its stepping off point for STEM initiatives. MSP supported the Vermont Mathematics Initiative (VMI) for K-8 teachers in the past. The VMI extended opportunities to high school staff training. Also from MSP, the Vermont Science Initiative (VSI) lead STEM professional development in Vermont. The VSI and the Vermont Science, Technology, Engineering and Mathematics Leadership Institute (VSTEM LEADS) both suggested integrated work in the disciplines, like engineering design into science practice, or math into science skills (Vermont Agency of Education, 2015). While the state's goals sought

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to improve academic skills integration and a network of skilled teachers, Vermont MSP did not suggest the loftier goals other states associated with a STEM definition.

Two other programs, however, addressed minority participation for STEM education in Vermont. STEM was used for its after school and summer programs with the 21st Century Community Learning Center. Like MSP, the 21st CCLC was a federal grant program for low-income families and students. “High quality STEM programs can advance learning, build skills and relationships, and contribute substantially to a high quality engaging program” (Vermont Agency of Education, 2015). Vermont used the state’s CTE department to focus on girls in STEM education. The STEM Equity Pipeline, a grant from the National Alliance for Partnerships in Equity (NAPE) and funded by the National Science Foundation, provided funds for VT CTE (Vermont Agency of Education, 2013). Vermont acknowledged the need for assistance with these programs but did not define clearly its objectives related to STEM. No bills from the legislative body have been written regarding STEM.

Washington

The state of Washington couched STEM in terms of literacy with the “ability to identify, apply and integrated concepts” related to STEM. Students who were able to achieve STEM literacy were able to illustrate the concepts “within and across the four interrelated STEM disciplines to improve the social, economic, and environmental conditions of their local and global community” (State of Washington Office of Superintendent of Public Instruction, n.d.). Two bills (HB 2621, 2010; HB 1872, 2013) support STEM literacy goals for schools in the state. Washington, like other states, also uses Title II funding from the Elementary and Secondary Education Act to support its

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Mathematics and Science Partnership (MSP) Program (State of Washington Office of Superintendent of Public Instruction, n.d.).

In its *Recommendations for Science, Technology, Engineering and Mathematics Education* (2010), STEM was considered important because it improves the workforce, solve challenges in energy, health, environmental protection and national security, improve the potential wage earnings of its employed persons, and help a democratic society. “STEM learning in Washington will not achieve its potential unless integrated and project based learning activities are embedded into the infrastructure of K-12 education” (Milliken, 2010). According to the report, STEM should be for all regardless of subgroup and background.

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Chapter 4

Results

The results were tabulated based on the research questions: (1) did a given state and/or commonwealth define STEM? (2) If yes, did the policy/statute use an integrated definition of STEM, the disciplinary STEM education, or both? (3) What was the given state's vision for STEM regarding goals and aspirations? Further questions relating to RQ3 include: (a) does the state attempt to address underrepresented groups in STEM education? Is the vision tied to economic output? Do STEM programs target isolated populations, like after school or gifted, or are the programs focused on the larger, general population for all? Tables 4-1, 4-2, 4-3, and 4-4 address the results.

Research commenced and was amassed on the fifty states from fall 2015 to early fall 2016. Content analysis was conducted during the research stage and again at the end of the completed states' analyses. A spreadsheet was used to compile the data collected from each state's definition and aspirations, as well as where the information was found, including government sponsored publications and websites, or executive orders, bills, and statutes.

The Internet proved to be the most popular source of policy materials, 58 percent or 29 of the states published STEM education materials on websites. Twenty-one states, or 42 percent, have written bills, executive orders or statutes regarding STEM education. While many states that did put into statute STEM education required annual publications, not all of the 21 states had follow-up reports. While 42 percent of states have published reports on STEM education in the last decade, it was not necessarily because of statutes, bills or executive orders.

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Number of States in Each Definition Model. From the states (n=50), four types of STEM education definitions resulted: the basic disciplinary definition of STEM education, the integrated STEM education definition, using both definitions in the policy materials, or using no definition without explaining the acronym. No definition type reached a majority. The integrated STEM education definition was used by the most states at 42 percent or 21 states. As a separate category, use of both the disciplinary and integrated definition was 30 percent of the total, or 15 states. When combining the first two categories listed here – integrated and integrated with disciplinary – 36 states or 72 percent had integrated vernacular in each state’s policy materials. As a statistic, integrated STEM education would be the overwhelming majority of states’ policies. Nine states, just 18 percent, used no definition in its policy materials. Finally, only five states – Arkansas, Kansas, Louisiana, New Mexico, and Utah - 10 percent used the disciplinary definition. Outside of the research questions, three states integrated arts into STEAM education: North Dakota, Rhode Island, and South Carolina. All three states had integrated STEM education as definitions (or both) for policy documentation.

Overall Goals and Aspirations with Mission Statements. After looking at the goals and aspirations of the states regarding STEM education, the economy was given most frequently as a reason to implement STEM programming. Three out of four categories, or states with STEM definitions, all have economy as a primary motivator related to STEM education. Thirty-nine states or 78 percent stated goals related to workforce, jobs or economic development. While 15 states, 30 percent, mentioned CTE for STEM education, six of those states did not focus on economic aspirations. A majority of states focused on STEM for all of its students, rather than just select groups (n=34, .68). Many

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states also mentioned that improving minority participation should be part of the plan to improve STEM education outcomes (n=28, .56). However, seven of those states only spoke of underrepresented minorities and did not also state a belief in opening access to STEM education for all, while 21 of the states did. As part of the methods of how the states would implement more STEM education, eight states stated improving the numbers of students in advanced coursework related to the STEM disciplines should reflect one of the pathways of improving STEM education. Nine states included after school programming as one of the ways to improve STEM education in the state.

Definition Models by Race to the Top Funding

Since the research was conducted in order of Race to the Top funding phases for chapter three, the below section analyzed states' definitions and their RTTT phases. Any possible connection and correlation between STEM education and RTTT was already discussed in the limitations section in chapter two. States were listed by phases for organization only, not as a research question.

Disciplinary STEM Education Definition Model. The following states used the discipline STEM Education policy definition: Arkansas, Kansas, Louisiana, New Mexico, and Utah. Of the five states, four applied for RTTT funding and did not receive any in the three phases. Only Louisiana received funding in the third round of RTTT.

Integrated STEM Education Definition Model. The following states used the integrated STEM Education policy definition: Alabama, Colorado, Florida, Georgia, Hawaii, Illinois, Indiana, Maryland, Minnesota, Nevada, New Jersey, North Dakota, Oregon, Pennsylvania, South Carolina, Texas, Vermont, Virginia, Washington, West Virginia, and Wisconsin. While none of the states received funding in the first phase,

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several did in the second. Five states – Florida, Georgia, Hawaii, Maryland, and Pennsylvania – received funding from Race to the Top in phase two. Three states were placed in phase three of Race to the Top: Colorado, Illinois, and New Jersey. Nine states other applied for RTTT but did not receive funding from the federal government. They include: Alabama, Indiana, Nevada, North Dakota, Oregon, South Carolina, Virginia, West Virginia, and Wisconsin. Four states did not apply to RTTT but have an integrated definition for STEM: Minnesota, Texas, Vermont, and Washington.

Both Disciplinary and Integrated Definition Model. Fifteen states used both disciplinary and integrated STEM definitions in the documentation. They include Alaska, Arizona, California, Delaware, Iowa, Maine, Michigan, Montana, New Hampshire, New York, North Carolina, Ohio, Oklahoma, Rhode Island, and Tennessee. The two states, Delaware and Tennessee, who received funding in the first round of RTTT, use both the disciplinary and integrated definition for STEM education. Three states were in the second phase of funding: New York, North Carolina, and Rhode Island. Of those three, North Carolina was the only state to offer a complete definition on policy documents, including rubrics for schools to follow for STEM integration in schools. Rhode Island and New York both required several different documents to define STEM education. The only state with both definitions, Arizona was in the third phase of funding, after not applying in the first round. California, Iowa, Michigan, New Hampshire, and Oklahoma all applied for RTTT but did not receive any funding, while Alaska, Maine, Montana, and Ohio did not apply for RTTT at all.

No STEM Education Definition Model. In contrary to the other three definition categories, all of the states applied for funding, however most did not receive anything.

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Only Kentucky (phase 3) and Massachusetts (phase 2) received funds. Connecticut, Idaho, Mississippi, Missouri, Nebraska, South Dakota, and Wyoming all applied but did not receive financial support from RTTT. Massachusetts was also distinct in that while it set forth STEM policy, it stated specifically that it refused to define STEM education.

Results Charts. The results on the subsequent pages tabulated STEM education definition categories and the goals and aspirations of the mission statements of each state as related to research questions.

CARMICHAEL: STEM DEFINITIONS STATE BY STATE

Table 4-1. States' Aspirations and Methods for Disciplinary STEM Education

STATE	Economy	Minorities	For All	AP/GT	Afterschool	CTE
Arkansas	✓	✓	✓	✓		
Kansas					✓	✓
Louisiana	✓	✓	✓			
New Mexico	✓	✓			✓	
Utah	✓		✓			

Table 4-2. States' Aspirations and Methods for Integrated STEM Education

State	Economy	Minorities	For All	AP/GT	After school	CTE
Alabama	✓	✓	✓			
Colorado	✓	✓	✓			✓
Florida	✓	✓	✓			✓
Georgia	✓	✓	✓			
Hawaii		✓	✓			
Illinois	✓	✓	✓			
Indiana	✓	✓				✓
Maryland	✓	✓	✓	✓		
Minnesota	✓		✓			
Nevada	✓		✓			
New Jersey	✓	✓	✓	✓		
North Dakota	✓		✓			
Oregon	✓		✓			
Pennsylvania	✓					✓
South Carolina	✓		✓			
Texas	✓					
Vermont		✓			✓	✓
Virginia	✓			✓		✓
Washington	✓		✓			
West Virginia	✓		✓			
Wisconsin	✓	✓	✓			

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Table 4-3. States' Aspirations and Methods for Disciplinary and Integrated STEM Education

State	Economy	Minorities	For All	AP/GT	After school	CTE
Alaska			✓		✓	✓
Arizona	✓	✓	✓		✓	
California	✓	✓			✓	✓
Delaware	✓	✓	✓			
Iowa	✓	✓	✓			
Maine	✓	✓	✓			
Michigan	✓		✓			
Montana	✓	✓				
New Hampshire	✓	✓	✓	✓		✓
New York	✓	✓				
North Carolina	✓			✓		
Ohio	✓	✓	✓			
Oklahoma			✓			
Rhode Island	✓	✓	✓			✓
Tennessee	✓		✓			✓

Table 4-4. States' Aspirations and Methods with No Definition on STEM Education

State	Economy	Minorities	For All	AP/GT	After school	CTE
Connecticut		✓		✓	✓	
Idaho			✓			
Kentucky	✓	✓	✓			
Massachusetts	✓	✓	✓			
Mississippi				✓		
Missouri					✓	
Nebraska						✓
South Dakota		✓	✓			✓
Wyoming	✓				✓	✓

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Chapter 5

Summary and Conclusion

Research Questions

The following research questions of this study dealt with a 50 state policy analysis of STEM education:

1. Did a given state and/or commonwealth define STEM education?
2. When a state and/or commonwealth defined STEM education, did the policy/statute use an integrated definition of STEM, the disciplinary definition, or both?
3. What was the given state's vision for STEM regarding goals and aspirations?
 - d. Does the vision attempt to address underrepresented groups in STEM education?
 - e. Are the goals of STEM education tied to economic output?
 - f. If STEM education policy exists, do STEM programs target isolated populations, like after school, gifted enrichment, or advanced placement, or are the programs focused on the larger, general population for all?
4. Did a state apply for Race to the Top in the three phases? If yes, did it receive funding and in what phase?

Significance of the Study

This study is significant for several reasons. First, while there has been analysis comparing the STEM labor definitions used by the leading national agencies (i.e. Bureau of Labor, NSF, Department of Labor), a comprehensive analysis of STEM education policy has not been completed before that looked at all of the states in the country. By examining all 50 states, the researcher was able to provide an overview of STEM

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education policy and how stakeholders define STEM education. Second, the economic industry as of 2017 has been grappling with terminology related to STEM and its characteristics. Therefore, this study is timely relating to STEM and how it is defined in the educational sphere. STEM education is in the popular education vernacular at the local, national, and federal level. Several agencies (i.e., NSF, CoSTEM, NRC, NAS) have relayed their own definitions and policy agenda. Finally, given the definitions, the researcher was also able to understand the goals and aspirations of states regarding STEM education, such as economic goals, supporting personnel, and target audience.

Implications of the Study

After examining the policy documentation, the researcher was able to illustrate how STEM education was defined in the given states and what the goals and aspirations of the policy vision. The researcher was able to analyze the results of the definitions across the groups of states and within the groups.

Disciplinary STEM Education. Five states defined STEM education as the four disciplinary subjects: science, technology, engineering, and mathematics. As Vasquez (2015) suggested this is the simplest definition of STEM education and easiest to implement. It often relates to the course work and job outlook related to the four disciplines. Arkansas, Louisiana, New Mexico, and Utah, or four of the five states cited economic concerns for STEM education. Kansas, however, did not discuss economics as an imperative to having a STEM education policy. Arkansas, Louisiana, and New Mexico addressed underrepresented minorities in its policy documentation. Three states – Arkansas, Louisiana, and Utah – aspired to have STEM education for all. Regarding methods of achieving STEM education, only one state, Arkansas believed advanced

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placement, gifted education, or enrichment models needed to be improved. Two states – Kansas and New Mexico– addressed after school programming. Finally, only Kansas approached STEM Education through CTE.

All of the states in this category had two or more goals or aspirations. Kansas and Utah had two. Louisiana and New Mexico had three, while Arkansas had four selected. **Integrated STEM Education.** Vasquez (2015) considered Integrated STEM Education as the hardest type of STEM education to implement, however, this level of STEM education was the largest definition assumed by the states. All but two of the 21 states, Hawaii and Vermont, cited economic concerns for STEM education. Eleven states – Alabama, Colorado, Florida, Georgia, Hawaii, Illinois, Indiana, Maryland, New Jersey, Vermont, and Wisconsin – addressed underrepresented minorities. Sixteen states aspired to have STEM education for all. Indiana, Pennsylvania, Texas, Vermont, and Virginia in their policy documentation did not address STEM education for all. Six states used CTE to define and implement STEM education: Colorado, Florida, Indiana, Pennsylvania, Vermont, and Virginia. Maryland, New Jersey, and Virginia addressed implementation with advanced coursework, gifted or enrichment education. Vermont was the only state in the group that discussed after school programming as a STEM education method.

Only one state had one goal towards STEM education. Texas cited just economics has an imperative. Nine states – Hawaii, Minnesota, Nevada, North Dakota, Oregon, Pennsylvania, South Carolina, Washington, West Virginia – had two goals selected. Three goals were selected by seven states: Alabama, Georgia, Illinois, Indiana, Vermont, Virginia, and Wisconsin. Finally, four goals and aspirations were selected by the following four states: Colorado, Florida, Maryland, and New Jersey.

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Disciplinary and Integrated STEM Education. Representing the most inclusive policy definition, fifteen states used both definitions to describe STEM education. Thirteen states cited economics as part of their goals and aspirations while two states, Alaska and Oklahoma, did not. Ten states wanted to improve underrepresented minority participation. They include Arizona, California, Delaware, Iowa, Maine, Montana, New Hampshire, New York, Ohio, and Rhode Island. Eleven states have indicated that STEM education should be for all. California, Montana, New York, and North Carolina did not. New Hampshire and North Carolina addressed implementation with advanced coursework, gifted or enrichment education. Only three states – Alaska, Arizona, and California - spoke about after school programs while five states – Alaska, California, New Hampshire, Rhode Island, and Tennessee – referred to CTE programs in STEM education policy materials.

Only one state had only one goal selected. Oklahoma believed that STEM education is for all students in the state. Four states – Michigan, Montana, New York, and North Carolina – had two goals and aspirations in their policy materials. More states had three selected: Alabama, Delaware, Iowa, Maine, Ohio, and Tennessee. Three states – Arizona, California, and Rhode Island – had four goals and aspirations. Finally, New Hampshire had five goals and aspirations.

No STEM Education Policy Definitions. Nine states did not have a STEM education definition. The category had few patterns emerge unlike the other three categories. Only three states – Kentucky, Massachusetts, and Wyoming – cited economics as a concern related to STEM education. Four states – Connecticut, Kentucky, Massachusetts, and South Dakota – were concerned in their literature about underrepresented minorities.

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Only two states – Connecticut and Mississippi – focused on advanced placement, gifted or enrichment coursework. STEM education for all was a sentiment shared by four states: Idaho, Kentucky, Massachusetts, and South Dakota. Connecticut, Missouri, and Wyoming cited after school programs. Finally, CTE was mentioned by Nebraska, South Dakota, and Wyoming.

Four states had only one goal or aspiration related to STEM education. The states were Idaho, Mississippi, Missouri, and Nebraska. Five states had three goals and aspirations: Connecticut, Kentucky, Massachusetts, South Dakota, and Wyoming.

In summary, regardless of STEM education definition most of the states are engaged in policy discussions. Seventy-two percent of states were found to have used integrated language regarding STEM education combining two models. These states often had the most to say about STEM education and hoped for outcomes. Some states have fleshed out STEM education in detail while others are beginning the process of looking at STEM in the classrooms, which explain the variance in models for goals and aspirations. For example, Rhode Island had changed its definition from STEM to STEAM and various stakeholders wanted the state to take on more research related to the subject as recently as fall 2016. STEM education has proven that multiple stakeholders are involved in the process: educators, parents, legislators, governors, businesses, and universities have different priorities regarding STEM education. As a result, no definition model reached majority in the states.

Implications for Practitioners. As governors, legislators, universities, and labor leaders discuss STEM education, the administrator at the school or district level must decide how to proceed with STEM implementation. The local practitioner must balance the guiding

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statutes, financial responsibilities, and priorities of the community. As seen from the research of this study, most states do not have STEM education statutes and regulations (only 42 percent), which leaves neighborhood schools able to make decisions about programs in their buildings. Overall, curriculum execution must be supported by budgets and funding to provide professional development, the creation and collection of classroom resources, hiring personnel, and develop assessments. Curriculum is supported by annual budgets, which in turn are created at the local, state and national level for school funding. Decisions about curriculum are varied depending on the stakeholders. For example when looking at implementing the Next Generation Science Standards, which is ultimately related to STEM education,

Much of the complexity of science education systems derives from the multiple levels of control—classroom, school, school district, state, and national—across which curriculum, instruction, teacher development, and assessment operate; thus what ultimately happens in a classroom is significantly affected by decision making distributed across the levels and multiple channels of influence. (NRC, 2012, 243)

These “multiple channels of influence” may also include other stakeholders like parents, businesses, and professional societies who exert varying levels of sway over curriculum priorities. School administrators must balance competing needs to deliver curriculum for the students. STEM education is only one of the programs possible in schools, and this study has shown that there are four possible models to define STEM education: disciplinary, integrated, disciplinary and integrated, or no clear model at all.

An administrator who wants to implement STEM education should be aware of the range of definitions. Looking again at Vasquez, Sneider, and Comer (2013), STEM education was characterized as a four-stage process, and the more integrated STEM education is with multiple disciplines the harder it is to implement. The states with

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integration at the policy level discussed and used the language of critical thinking, real world application, and problem-based learning. The four-stage definition provides an outline of STEM education integration and early priorities for implementation for educators.

Another resource for practitioners includes what 21 states have already provided with guiding documents from the resident state's Governor(s) Council on STEM (or Science) and/or Strategic Plans. The Council reports often discussed implementation, best practices and local resources. In addition, practitioners with integration in mind could look at North Carolina's rubrics (2013) on STEM programs, which fully identify and promote comprehensive STEM schools. It had four stages of STEM schools with identifiable program attributes. The four stages that schools could be characterized for with STEM education include Early, Developing, Prepared, and Model. Texas, another state that has used the integrated definition model, has a self-assessment rubric to be part of the T-STEM program. The Texas Continuum Growth Scale also had a four-stage rubric: Developing, Implementing, Mature, and Role Model (Texas Education Agency, 2015). As stated in prior analysis, states using the Integrated Model often had the most resources with STEM education.

In addition, what makes the integrated STEM education definition useful for administrators is that much of the language used to describe it is universal to good curriculum in the researcher's opinion. When discussing the humanities, the arts or literacy, engineering and technology can be used to assist other disciplines besides science and mathematics. Local districts that have other priorities involving improving language arts programs might use STEM education's problem-based learning to assist

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with critical thinking in the design thinking approach of engineering design. Simplified engineering design begins with a problem, possible solutions, testing the prototype and then making adjustments to the prototype to make a model to help solve the problem. A writing assignment can work in a similar manner: 1) restate the problem for an audience, 2) complete an outline, 3) write out a rough draft, 4) edit with feedback, 5) finish the writing product using input from the rough draft, and 6) present to the audience. The engineering design cycle can be applied to multiple subjects. Yet, once again, the school administrators must lead with a curriculum that fits the needs of the school community.

Topics for Further Research

Several topics arose during the research phase of this study that continue to go unanswered. First, the question has come up about the eventual effectiveness of the definition models regarding student achievement. Effectiveness may be answered by a different research question. For example a possible question may include: does an integrated model, over a disciplinary model, impact educational practice with student achievement? Quantitative studies may be necessary to compare the two models in education. Second, funding models of the STEM programs were alluded to during the research but not pursued. For example, private-public partnerships were found in over twenty states, particularly with the STEMx model. In addition, federal programs, such as Race to the Top, Mathematics and Science Partnerships, 21st Century Community Learning Centers, and CTE Perkins grants all support STEM programs. A follow up question could be: are these effective models for student achievement and/or policy implementation in STEM education? For example, while this study referred to the RTTT funding, the effectiveness of the funding model regarding STEM education was not

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included in the state reports required by the DOE even though STEM education was considered a competitive priority of the program. Overall, 19 states received funding from RTTT. Third, it would be interesting to see why each state has chosen its STEM education policy definition. States that have integrated definitions may be using research that calls attention to so-called STEM education deficits. A few states did cite similar research found in this study. For the states without STEM definitions or those that have disciplinary definitions, it would be intriguing to find out if the definitions were formed from counter research that showed the US has actually been good in STEM economics and education performance or if the policy makers have neglected STEM education as a policy issue entirely, and therefore, have not added to STEM education terminology and missions. Finally, policy has an evaluative quality that was not included in this research study. Topics could include how well it was implemented related to the goals, perceptions of the outcomes by the stakeholders, have the target audiences changed in relation to the goals, or comparing the states by definition category related to the goals and their outcomes. The next immediate step after this study could be evaluative in nature.

Final Conclusions

Overall, the majority of the states have STEM programs, clearly defined by policy. The spread of STEM education programs and policies in the country, particularly after Race to the Top, has proven that STEM education has become a popular topic in education. Most states have documented their STEM education policies with websites, strategic plans, legislation, or executive orders. STEM education has national and state, and ultimately local policy implications and have set forth goals and aspirations going

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forward. For the most part, the states connect STEM education to economic goals. From state to state or even within a state, not all policy stakeholders have used the same language, as evidenced by the study. Therefore, the confusion over terminology has potential bearing in quality implementation, financing, and professional development. The range of states use of terminology has impact in the education sector.

Researching STEM education definitions policy was challenging. Not all states have clear terminology and many sources were needed from each state to decipher the language used in policy. It was easiest when a state had a definition and mission statement. Many states did but others had to be gleaned from multiple stakeholder sources.

Some states have also made STEM education a visible priority for the students and have enlisted multiple partners in creating coalitions for programs. Some of the partnerships included universities, leading STEM industries within the states, departments of education, and model schools. While other states have stakeholders who have not created a shared vision. For some, STEM education has not been a priority in the public sphere. For example, certain states have not changed much from the CTE and disciplinary definitions or do not have plans of action regarding policy. This lack of defining mission illustrated that STEM education has yet to be a major part of the education platform. Overall, the field of STEM education has changed since the early days of Race to the Top. Very few states had STEM education as a policy priority in 2010. Yet as of 2017, most states have set forth at least a minimal policy agenda. It will remain to be seen if STEM education continues to trend in education policy.

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Appendix A

States that applied for Race to the Top Phase 1 in the order they performed:

- | | |
|--------------------|-------------------|
| 1. Delaware | 21. Hawaii |
| 2. Tennessee | 22. Indiana |
| 3. Georgia | 23. Iowa |
| 4. Florida | 24. Connecticut |
| 5. Illinois | 25. Wisconsin |
| 6. South Carolina | 26. California |
| 7. Pennsylvania | 27. Idaho |
| 8. Rhode Island | 28. Kansas |
| 9. Kentucky | 29. New Mexico |
| 10. Ohio | 30. Virginia |
| 11. Louisiana | 31. Wyoming |
| 12. North Carolina | 32. Missouri |
| 13. Massachusetts | 33. Oklahoma |
| 14. Colorado | 34. Oregon |
| 15. New York | 35. West Virginia |
| 16. Arkansas | 36. Alabama |
| 17. New Jersey | 37. New Hampshire |
| 18. Utah | 38. Nebraska |
| 19. Minnesota | 39. Arizona |
| 20. Michigan | 40. South Dakota |

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Appendix B

States that did not apply for Race to the Top (2009) in the first round:

1. Alaska
2. Maine
3. Maryland
4. Mississippi
5. Montana
6. Nevada
7. North Dakota
8. Texas
9. Vermont
10. Washington

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Appendix C

States that applied in later phases of Race to the Top:

1. Maine
2. Mississippi
3. Maryland
4. Montana
5. Nevada
6. Washington

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