AN ELEMENTARY EDUCATOR’S RESOURCE GUIDE TO

STEM-INTEGRATED CURRICULUM THAT ADVANCES STUDENTS’

SCIENTIFIC LITERACY

A graduate project submitted in partial fulfillment of the requirements

For the degree of Master of Arts in Education,

Elementary Education

By

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Abstract

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By

Andrea Figueroa

Master of Arts in Education, Elementary Education

This project/website is intended to provide pre-service teachers, beginning teachers, and teachers in grades Kindergarten through Eighth who are interested in implementing Science, Technology, Engineering, and Mathematics (STEM) in their classrooms. Teachers who are unfamiliar or uncomfortable with teaching according to the Next Generation Science Standards (NGSS) and don’t know where to begin implementing STEM into their daily curriculum, will find helpful resources and lessons to begin the process of teaching STEM, primarily Engineering into Core Curriculum lessons. Through the use of how-to-guides, pre-made lessons, and additional educator support, teachers will find resources to begin building a solid foundational understanding of STEM integration and student engagement. This website begins by explaining what STEM is and what purpose it serves. Along with valuable teacher resources and literature that supports the importance of STEM in the classroom; this website will help both new and veteran teachers bring the future of education to their students.
Keywords: Science, Technology, Engineering, and Mathematics (STEM), Next Generation Science Standards (NGSS), STEM Integration, Student Engagement
CHAPTER ONE: INTRODUCTION

As an elementary educator in today’s world where many careers require deeper and more dimensional knowledge, skill and learning dispositions in science, mathematics and technology (STEM), I have come to understand that it is important to place more emphasis on these subject areas in the elementary school classroom. My story is all too typical of students who have been educated over the past several decades. Growing up, I was never taught in such a way that I became interested in science or mathematics. Many of my teachers did not teach science daily or even weekly due to the time constraints imposed by the emphasis upon literacy development for English Language Learners (ELL) and the rising amount of local, state and national tests on mathematics and reading. Science, along with social studies, the arts and physical education was always put on the back-burner and sadly I missed out on this important discipline. It wasn’t until I got older and entered high school that I realized how vital knowledge of science was in deciding on and accessing a satisfying career. In fact, many of the careers I was interested in required good grades in science and mathematics as well as extra courses in advanced science. It is safe to say that I was limited in my pursuit of a career.

Now I know as a teacher, that If I had only been given ample engagement and learning in science education that was meaningful to me during my younger elementary years that I may have felt more comfortable in selecting a college major in science. I understand that teaching the basic skills in elementary school builds a solid foundation for the future, but we need to understand that Multiple Literacies doesn’t just focus on reading, writing and math anymore. Science and technology need to now take part in daily curriculum taught in grades K-8. Having completed a graduate program in STEM education (science, technology, engineering and mathematics) I am now convinced that elementary school teachers can make sure that diverse
students will not live my story in elementary school. They will be educated in a STEM-integrated manner that prepares them to have choice and access to higher education majors and careers in the science disciplines. Most importantly the engineering curriculum that I plan to present in this resource project will not only meet the Next Generation Science Standards, but it will also help to achieve Common Core standards as well. Common Core includes four important skills, also known as the “four C’s” as an integral part of the standards. The four C’s include Communication, Collaboration, Creativity and Critical Thinking, and it is significant to note that teaching according to these skills can be complex and difficult for some teachers. Engineering curriculum, however, meets all four of these skills while also allowing students to reach an engineering state of mind by working through the engineering design process.

The focus of this Project is to present an Educator’s Resource guide for elementary teachers seeking to advance the scientific literacy of their students through the implementation of the “E” in STEM—engineering curriculum and instruction, which meaningfully integrates mathematics and science content. As a STEM educator, I now realize how many of my students yearn for daily science content and look forward to learning new concepts as they engage in new, meaningful projects that connect to their own inquiry and experiences. My upper-elementary students love to see how engineering works as they experience its applications to and from science, mathematics and technology. Most importantly, they recognize how STEM discipline integration plays a key role in the development of new materials, technologies and scientific advances. This project is not only making it possible to focus on STEM curriculum, but also Common Core.

This Project will assist upper-elementary teachers who seek effective strategies to inspire, welcome, engage and retain more students from minority-serving elementary schools in
obtaining scientific literacy. It responds to the need for teachers to access not only a carefully-prepared resource guide, but also the scholarly and research literature that supports their efforts to lead STEM-integrated curriculum. It has been specifically designed to assure that students from underserved populations are led by a teacher who has benefitted from a training program of STEM-integrated curriculum, instruction and assessment. The Project specifically focuses on the implementation of engineering curriculum for upper-elementary students. By incorporating E in STEM (engineering) content and design processes in this Educator’s Resource, teachers will have easy access to STEM curricula, tools and strategies for promoting student engagement and success in science. In addition, they will understand why leading their students in STEM activities that develop their learning dispositions (Costa and Kalick, 2015) will promote satisfying engagement in engineering tasks that are integral to solving real-life problems. The resource will enable teachers seeking to make a difference in the life trajectory of their students, to acquire positive perceptions of their ability to succeed in STEM disciplines. I also want to point out that the Engineering resources presented were created and gathered with English Language Learners in mind. The resources provided incorporate the English Language Development goals of allowing students to read, analyze and interpret information as well as understanding the complexity and dynamics of the language. The engineering projects included allow for ample collaboration and communication among all students at every ELD level covering both Common Core as well as ELD standards.

To achieve ample dissemination of this Project, an educational website has been created. This site STEM Integrated Curriculum Resources, serves as a guide for teachers to access standards-aligned activities, lesson plans, and assessments as well as online resources and scholarly literature on STEM-integrated curriculum, instruction and assessment. With these
resources I am hopeful that educators in diverse environments like myself, will be able to implement STEM content and be successful in doing so.
CHAPTER TWO: LITERATURE REVIEW

Incorporating STEM-integrated content into the elementary school classroom is difficult for any teacher; especially one who has not been formally trained in the models, concepts and strategies needed to plan, teach, reflect and assess this robust curriculum. Ford (2007) states that teachers’ confidence for teaching STEM is an important predictor of their ability to lead STEM-related content. Teachers who aren’t trained in STEM integration lack confidence in teaching it and therefore leave it out of the daily curriculum (Berg & Mensah, 2014). Surprisingly, years of teaching experience is not seen to be associated with lack of knowledge or lack of comfort (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). While I have only been teaching for three years I have acquired comfort in teaching STEM-related content. This is because I have completed a graduate program of study in STEM Curriculum and Instruction. I have had many experiences to familiarize myself with the knowledge, skills and dispositions (KSD) that my students need in order to achieve in STEM disciplines. While I have 240 minutes of weekly science instruction with my middle school students, I encounter a variety of constraints that affect the time available to lead meaningful science lessons. This relates to what Berg and Mensah (2014) state about science instruction being limited due to lack of time. The subsequent lack of student exposure to integrated-STEM curricula results in a lack of interest for students in pursuing achievement in these disciplines (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013).

As students get older and move into the more difficult areas in science, most of them become disinterested in pursuing careers in STEM fields. This may be because they have not been routinely exposed to these topics, particularly engineering (Kimmel, Carpinelli, Burr-Alexander, & Rockland, 2006). STEM-qualified elementary school teachers are needed to
advance student engagement and perception of successful knowledge attainment in STEM disciplines. Teacher unpreparedness and lack of awareness of STEM-teaching practices plays a key role in the lack of students’ desire to pursue a major or career in STEM. Research has shown that students do not acquire interest in STEM because they are not given relevant topics in these areas and therefore are not prepared to enter STEM programs in college (Kimmel, Carpinelli, Burr-Alexander, & Rockland, 2006). In addition, many students do not understand the problem solving process is integral to acquisition of STEM concepts, simply because of the way it is taught (Kimmel, Carpinelli, Burr-Alexander, & Rockland, 2006). According to the Secretary's Commission on Achieving Necessary Skill Report (SCANS, 2014), teaching should be taught in context, and students should learn content while solving realistic problems. SCANS reports determine the skills our young people need to succeed in the world of work, allowing us to plan and prepare for what we should be teaching our young students. If we provide students with meaningful STEM applications they may develop the skills needed to grasp problem solving processes which is half the struggle.

When teaching STEM content, there are many opportunities to cross disciplines and plan lessons where supplemental curriculum can be incorporated while also covering material that is listed in the state standards. For instance, engineering curriculum has gained more attention recently with its inclusion in the Next Generation Science Standards (NGSS, Bamberger & Cahill, 2012). Since these two content areas are so closely related it makes it easier to implement engineering design processes into the study of science. According to the National Research Council (NRC, 2011) engineering is considered a systematic approach to designing objects that meet human needs and wants. This description justifies my reasoning for creating a resource guide in which teachers can offer their students opportunities to participate in tasks that would
allow them to design and build objects that are used in the real world. Projects that require students to design roller coasters and cars, for example are beneficial because they are familiar objects that are used every day. As Appleton and Lawrenz (2011) mention, students tend to do better with content that has both meaning and has value for them. These projects also require the integration of mathematics and science concepts. As the National Council of Teachers Mathematics (NCTM, 2015) states, “Problem solving should be the central focus of the mathematics curriculum. As such it is a primary goal of all mathematics instruction and an integral part of all mathematical activity”.

Engineering is one STEM area that is seldom taught to elementary, middle and high school students because of lack of professional training. Very rarely are engineering teaching strategies or processes taught in teacher preparation programs. The core subjects such as reading, math, and history are highly concentrated in teacher preparation programs because those are the areas in which future teachers’ students will be tested. This reality has led to lack of training and preparation in other areas such as science and engineering, which are main components of STEM. Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester (2013) state that the amount of STEM education required in most elementary teacher preparation programs is minimal and extended research on this condition has also revealed that the lack of teaching inquiry (scientific, social and mathematical) based content is due to teachers’ limited exposure and experience with STEM (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). Effectiveness in teaching STEM is also influenced by teachers’ attitudes towards STEM (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). Teachers with negative attitudes toward STEM tend to avoid teaching STEM content, which results in poor student attitudes toward these subject areas (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013).
Low teacher confidence in one’s own ability to lead STEM learning can also impact a student’s learning. Research evidence has supported the idea that a lack of knowledge can make a teacher feel unsure about his or her teaching abilities resulting in an overall feeling of being uncomfortable with STEM curriculum (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). Teachers lack confidence for teaching STEM disciplines because they are not familiar with the manner in which concepts and ideas interact. This lack of confidence results in less time spent teaching these subject areas. Teachers are inclined to teach what and how they were taught in school and sadly many were not taught proper STEM-learning techniques (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). Studies have proven that it is valuable to invest the necessary resources to help teachers provide the best STEM education for their students (Avery & Reeve, 2013). Time allotment also plays a huge role in the teaching of STEM content. For example, it is reported that teachers feel that since science is the least important when it comes to moving onto the next grade, it should be the first to be excluded (Berg & Mensah, 2014). As Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester (2013) found in their study, students are very easily influenced at the elementary-school level. It is at the elementary level that individuals begin to develop perceptions and knowledge of STEM. For this reason it would be beneficial to stimulate their awareness of STEM and desire to achieve in these disciplines at this age (Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester, 2013). By including engineering design processes and content in K-12 classrooms, educators can provide a better understanding of the components of a technical or advanced professional career to more students at an earlier age (Norman, Moore & Kern, 2010). The potential benefits of providing our students with high quality STEM activities and instruction are reason enough to implement engineering principles into science content. The American Society for Engineering Education asserts that it is important
that K12 teachers have a foundational understanding of the nature of engineering and how to integrate engineering into their classroom practice (Norman, Moore & Kern, 2010).

In today’s global society there is a critical need to increase students’ interest in STEM -- and place more of an emphasis on engineering design processes as any of the other content areas (Avery & Reeve, 2013). The process of design is both complex and creative, and provides satisfying challenges for our students (Bamberger & Cahill, 2012). And as I mentioned in Chapter 1, CCSS includes creativity and critical thinking as essential skills. So by introducing engineering design principles in the elementary-school grades we are creating problem–based challenges for our students that will allow them to be inventive, critical thinkers who can arrive at their own individual solutions (Bamberger & Cahill, 2012). The open ended tasks associated with engineering design and problem solving require our students to become self–directed and motivated to achieve, which results in a sense of personal drive within (Bamberger & Cahill, 2012). According to Galvin (2002) the United States is in need of technically-literate and engineering-minded workers in order to maintain its global leadership in many vital industries. In most recent years companies in America have spent about $ 60 billion annually on continuous training of their workforce in the basic skills (communication, collaboration, critical thinking and creativity) that should have been taught at school (Galvin, 2002). Post-baccalaureate medical, engineering and business schools have even revamped their curricula to focus on more open-ended thinking and problem-solving techniques as these are key components of the professional curriculum (Woods, 1997). Indeed, the industry-led movement for national standards now known as CCSS is evidence that the common K-12 curricula across the nation have not been providing U.S. students with the proper preparation at an early enough age to meet the needs of the 21st century workforce. With a perception of the steep track to make up for lost time, and
preconceived attitudes many educators become overwhelmed. This can result in K-12 teachers’ development of persistent, negative perceptions of STEM with the unintended results that before students middle school they too have little motivation to pursue what to them seem to be unreachable majors and careers.

The STEM knowledge, skills and dispositions that students must obtain by and through middle school are the foundation for a successful career in STEM (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). Attitudes formed by middle school also have a big influence on what STEM courses students will take in high school. Studies have found evidence that how students feel about the usefulness of the content affects their attitudes about STEM (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). The type of STEM-discipline work that students complete during the school day also influences these perceptions, and determines whether students find the information of value and importance (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). And as Knezek, Christensen, Tyler-Wood, & Periathiruvadi (2013) note, engineering is often entirely neglected in the school curriculum, which results in students having no awareness or use for the content.

There are several other factors that influence whether a student will decide to pursue a major or career in engineering (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). Some of these factors include students’ parents, peers and teachers’ attitudes about STEM careers (Knezek, Christensen, Tyler-Wood, & Periathiruvadi, 2013). Many students have a basic misunderstanding of what engineering is and what engineers actually do because they are not given proper examples. Ball (2014) stated that it is common knowledge that teachers teach in the way that they were taught when they were students, resulting in many not providing high quality or integrated-STEM instruction. Cunningham (2012) also researched the idea that teachers
should be reviewing their practice daily by partaking in a Critical Reflective Practice Method. This allows administration the opportunity to directly capture and document the experiences in the teacher’s classroom. This would make it possible for teachers to be more reflective in their practice and enable many more to improve their teaching practice and educate themselves on innovative ideas. But as mentioned earlier, in order to encourage teachers to integrate STEM disciplines into other subject areas, teachers’ training programs need to provide integrated-STEM content and cooperative learning experience. If we expect our students to flourish with hands-on approaches to higher-order thinking and problem solving, so must teachers be prepared in meaningful contexts with adequate resources to lead STEM-integrated curriculum, instruction and assessment (Norman, Moore & Kern, 2010). As Knezek, Christensen, Tyler-Wood, & Periathiruvadi (2013) assert, more teacher preparation in leading hands-on activities is needed to help K-12 students to become aware of and fully understand what it means to be an engineer.

Student-teacher relationships in a STEM integrated curriculum, in the form of caring, is also a key component of academic engagement (Skinner, Furrer, Marchand & Kindermann, 2008). For example, I acquired understanding in my STEM graduate program that while implementing engineering in science content it is also vital that teachers know how to assure student engagement, particularly through authentic, collaborative group work and hands-on activities (Wolf & Fraser, 2007). Students should acquire the social skills and dispositions that enable them to engage with peers in a safe and caring learning environment, in which they may share ideas, solutions and findings (Wolf & Fraser, 2007). Such academic engagement paves the way for student success in the areas of grades, attendance, and graduation (Skinner, Furrer, Marchand & Kindermann, 2008). Students who are engaged in school are more academically successful and more likely to avoid getting into trouble as they reach adolescence (Skinner,
Furrer, Marchand & Kindermann, 2008). Children and adolescents who tend to be more engaged in school are so because they receive adequate teacher involvement, and academic peer approval as opposed to children who are more withdrawn because they lack teacher support or fear peer judgment (Skinner, Furrer, Marchand & Kindermann, 2008). Skinner, Furrer, Marchand & Kindermann (2008) have learned that children who are bored may apply less effort and stop paying attention to the teacher, resulting in becoming more bored over time. Their studies have shown that when students become bored, frustrated, or anxious about school work, their behavioral participation in academic activities declines (Skinner, Furrer, Marchand & Kindermann, 2008).

There are obviously many obstacles that K-12 teachers face when trying to introduce engineering into general curriculum. Teachers today will need to adapt to new standards (CCSS, NGSS) as they adopt new classroom procedures and instructional practices that are required to properly incorporate the engineering design process. They need to be prepared to address many questions about how things work and how both mathematics and science are connected to engineering design (Bamberger & Cahill, 2013). This makes it more difficult for teachers who are used to providing answers to questions about what and why things happen (Bamberger & Cahill, 2013). It is also important to point out that in engineering design there are no perfect solutions. Every design challenge has numerous solutions that could possibly work (Bamberger & Cahill, 2013). While this makes it easier for students to become more successful when designing prototypes and might encourage students to actively participate, it makes it more difficult for teachers to feel they are in control of the task at hand (Bamberger & Cahill, 2013).

Another difficulty teachers may encounter is the ability to nurture creativity in their classrooms while still providing proper scaffolding in order to support learning (Bamberger &
Cahill, 2013). Bamberger and Cahill (2013) suggest that teachers provide materials and resources that promote creativity in a hands-on type of experience. Students also need to learn to be open to problems they may encounter when working on engineering activities and STEM projects. This goes back to Habits of Mind by Costa and Kallick (2015) as mentioned in chapter 1. Costa and Kallick (2015) describe Habits of Mind as “having a disposition towards behaving intelligently when confronted with problems.” Students need to be efficacious and stick to a task without giving up. Therefore positive peer experiences need to occur first, so that students can seek to become effective problem solvers.

And as mentioned earlier in this review, Wolf and Fraser (2008) feel that students should be able to engage with their peers in hands-on experiences in order to increase their academic engagement. But first, educators must assure that in addition to knowing how to promote student acquisition of basic (and multiple) literacy skills they also have competencies in developing students’ higher-order thinking (Kirkley, 2003). It is optimal for upper-elementary through secondary-level students to use their knowledge in order to perform critical-analysis tasks and solve problems on their own. However the ability to engage in problem solving depends on mastery of basic literacy skills (Kirkley, 2003). This is a key reason why the structure of problem, inquiry-based learning is important for teachers to acquire as it combines the expectations of basic skill development with the outcomes associated with Common Core, English Language Development and Next Generation Science standards. The four C’s of Common Core as well as the ELD and NGSS standards can all be met if we focus on Costa and Kalick’s Habits of Mind (2015).

With respect to the ELD standards that the resource guide will address in this project is the idea that has resonated within me as a Latina educator--that teaching is not
transcendent. Gay asserts that good teaching should not be identical for all students, settings and circumstances, and it should not be reflective of the style of teaching that teachers were exposed to when they attended grade school (2010). With this project I have been intentional in providing resources and hands-on applications for teachers in minority-serving schools. According to Gay (2010) too many teachers plead ignorance of Latino(a), African, Native and Asian Americans, and other immigrant groups. This ignorance of people who are different from us often leads to negative attitudes, anxiety and fears (Gay, 2010). In STEM as well as other content areas, these negative attitudes and fears can harmfully influence students’ perception of and desire to acquire knowledge and achievement in various disciplines. I am seeking to provide important resources that lead to positive interactions amongst students and their peers. By offering minority students ample opportunities to acquire skills that they can use and projects that are within their frame of reference, we are providing them with valuable E in STEM experiences that become meaningful to them. Being culturally responsive while planning and teaching engineering activities as examples of integrated STEM disciplines educators empower all those involved (including themselves) and enable their students to become better human beings and more successful learners (Gay, 2010).
CHAPTER THREE: METHODOLOGY

About the Project

To assist other educators in understanding the importance of STEM subject areas and aid in the advancement of scientific literacy in elementary classrooms, my educator’s resource website, STEM Integrated Curriculum Resources (www.stemintegratedcurriculumresources.weebly.com) was created. Each page of this website and the resources included were carefully evaluated with the Next Generation Science Standards in mind. When visiting STEM Integrated Curriculum Resources, educators will be introduced to what STEM integration is and why the Engineering portion stands out; be able to explore engineering lessons for grades kindergarten through eight, and learn more about the standards that are addressed through STEM-discipline integration. The “In the News” section allows teachers to explore articles on why STEM is vital in lower-elementary grades, while also being able to view a few videos on how STEM is the future. This website serves as a start-up guide for those seeking to implement STEM into their classroom, while using real-life applications and introducing meaningful projects to elementary school students.

About the Author

“About me” includes a short biography of Andrea Figueroa and why STEM has become critical to her teaching in the past three years. I want other educators to know that I am far from being an expert in science, technology, engineering and mathematics, but have recently received supplemental training in STEM. Like many beginning teachers I had little knowledge of what expectations would be “thrown” at me when I became appointed as a full-time private school teacher. Despite not having a science background, I was asked to teach science at the middle
school level. It was up to me to as a credentialed multiple-subject teacher to seek out information and resources in order to provide high quality science instruction and grade-level six through-eight- appropriate material to my students. And even though it was both difficult and expensive to enroll in an accelerated and intensive STEM graduate program, I am now more informed and able to share many resources with others who may be in the same position in which I recently found myself. Being an educator dedicated to truly reaching and teaching diverse students today is difficult and fought with ever so many new obstacles. Teachers are expected to overcome these while assuming the many responsibilities required to order to teach our students what they need to know in order to advance in their schooling and careers. As Berg and Mensah (2014) state, teachers who are not trained in STEM integration lack confidence in teaching it, and tend to leave these subject areas out of daily learning. This is why I am hoping that this resource site will provide some of the needed support for those seeking to lead STEM learning in their classrooms. STEM-integrated curriculum and instruction is one of those important steps we must take along with our students in order to assure that they are able to succeed in high school, college and advance to meaningful careers. By sharing my background and some information that I have obtained along my journey, I am hoping to inspire other educators to take a chance with STEM instruction and reach out to other educators who may be in the same situation as them.

**About STEM and Engineering Integration**

In the opening paragraph of this page I have invited viewers to become aware that integrated STEM allows students to learn in a more dimensional manner and introduces our children to disciplines that are required in higher education college majors as well as science careers. Students who are introduced to integrated STEM learning will have more choice when
entering college and be more prepared for any career of their choosing. They won’t be limited based on the lack of science and math exposure, as I was when I was entering college. As previously mentioned in the literature review, Kimmel, Carpinelli, Burr-Alexander, & Rockland (2006) have found that students become disinterested in STEM fields because they have not been routinely exposed to all of its disciplines, especially engineering. If we make it a priority to expose our students to all STEM content they will not only better understand it but they will also become more prepared for high school and college (Kimmel, Carpinelli, Burr-Alexander, & Rockland, 2006).

On this webpage you will also find a paragraph that is entitled “Why does the “E” in STEM stand out?” I included this information because educators might want to know why I placed an emphasis on engineering as opposed to math or science--subjects that could easily be taught daily in a classroom. I focused on engineering primarily because everything around us has been created by a person or machine. Before being created it had to first be designed by someone or a group of people. Many people don’t think of engineering as being a meaningful activity that occurs daily in our society. When talking about STEM we mention how meaningful activities need to be incorporated in order for engagement to take place. If engineering is the basis for product creation then why not focus on engineering as the fore front of STEM in your classroom? Engineering allows students to design and build products that can be used in the real world. It also allows students to problem solve and go through the cause and effect process. Engineering can easily incorporate so many other parts of the Common Core curriculum as well as the ELD standards, aside from also being more recently included in the NGSS standards. And, as Costa and Kalick (2015) mention, leading students in STEM-integrated curriculum and
instruction will develop their learning dispositions and promote satisfying engagement in engineering tasks and processes that are integral in solving real-life problems.

Lastly, the Next Generation Science Standards for Engineering Design are included at the bottom of this webpage by grade levels, K-2, 3-5 and 6-8, exactly how the lesson plans included are categorized. Since the STEM Integrated Curriculum Resources website incorporates a good deal of information that focuses on the NGSS standards it was important to include standards on this page as opposed to the Resources page found later in the site. I want educators to become familiar with relevant resources as they move through the “how-to-guide” as they view the sample projects. It is also important to note that engineering is becoming a “big deal” because of its inclusion in the NGSS standards, (Bamberger and Cahill, 2012).

**Incorporate Engineering into Your Curriculum**

Under the Incorporate Engineering into Your Curriculum tab on the website, you will find the How-to-Guide, Sample Projects and Engineering Resources. This landing page contains the most important context of STEM information included on this website. Educators and STEM leaders world-wide are given a preview of what it takes to begin implementation of STEM at any grade-level classroom as well as what types of projects are suitable for each grade level subset, lower elementary, upper elementary and middle school. Visitors are also provided with information regarding future workshops conducted by JPL experts and videos on how to read the NGSS standards for those who are confused. This part of the website will also require monthly updating and constant reformatting so that it provides most recent information.
How-To-Guide

The How-To-Guide portion welcomes teachers by letting them know this information can be used prior to assigning projects in the classroom. It is meant to ease teachers’ anxiety and let them know it really isn’t that complicated and only a few steps are required. The first step provided is “Build Knowledge” for the teacher or whoever wishes to implement STEM. This step lets teachers know that it is important for them to build their own knowledge of STEM and what a STEM lesson should contain. Obviously this step is already being completed because they are viewing a resource website that is providing them with additional information aside from their own knowledge, so that is a step in the right direction for them. This portion also lets them know that a solid STEM lesson should include real-world, meaningful experiences (Appleton and Lawrenz, 2011), as well as including collaboration and communication amongst students in the class, which then meets two of the four C’s in Common Core.

The next step “Seek Resources” informs teachers of the ways in which they should be locating new STEM information aside from just looking online. It suggests reaching out to other teachers in neighboring schools or districts, finding online resources that also allow teachers to meet or connect with other STEM educators, and lastly, finding sample lessons that meet their grade level standards and objectives. There are also blogs that enable educators to communicate asynchronously and ask or leave suggestion. Again, this step is being reached by simply visiting this website and informing one’s self.

The third step “Implement Challenges and Tasks” informs teachers that once a great lesson or tasks has been found and is ready to be given to students, they must first set the ground rules for what is expected. Teachers must let students know about the social skill and habits of
mind expectations before the project is given. Such expectations and rules must be clear for all students so that there is no confusion. Classroom rules or norms should be reinforced at all times before and during projects if necessary. Since students will be excited and eager to work on the tasks and novel situations of inquiry given, they must first be prepped with what the task is and given clear directions of how to work collaboratively as team members in order to satisfactorily complete the project. Teacher supervision is required at all points as the teacher should be monitoring the students’ participation and prompting them to meet their challenges by asking questions if necessary, which enables them to maintain the children’s motivation. As student teams are all working towards a final goal, they need to be reminded of what that goal is in order to fully understand the importance of their working to achieve the task’s objective.

In a real sense, this section is the most important of the How-To-Guide because it reminds teachers that some rules or classroom norms do need to be in place before introducing integrated STEM instruction. It is not just a group project for students to work on. It is a before and during-instruction challenge that requires a dimensional flow of monitoring from direct instruction, guidance through exploration and discovery to active problem solving and construction. It also lets teachers know that students will be best engaged throughout the tasks if they have been provided with sufficient instruction to understand the rules and expectations. Because the nature STEM-integrated activities is characterized as “student thinking leads the lesson” with minimal support from the teacher, problem solving becomes a big part of the learning process for teachers. Students need to be given opportunities to utilize their creative and critical-thinking skills (Bamberger & Cahill, 2012), which is why monitoring and interaction is required at all stages of the lessons.
The last step of this guide is the “Have Fun” portion. It reminds teachers to have fun and show their enthusiasm when introducing these activities. Students feed off of our energy and if we look bored and uninterested, students won’t care about the task given. They will become disengaged and fail to participate. As Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester (2013) state, effectiveness in teaching STEM is also influenced by the teacher’s attitudes towards STEM. Teachers with negative attitudes toward STEM usually find little success in developing positive student attitudes toward these subject areas. We want students to become excited about STEM, most importantly engineering, but we need to be excited about it as well. This is why I left this step as the last one as a reminder to educators that our perceptions and attitudes set the tone for the learning environment.

**Sample Projects**

The next section of the website under the How-To-Guide tab is the Sample Projects tab which then includes projects by grade levels, K-2, 3-5 and 6-8. This section is what most teachers should be looking for when trying to implement STEM into their classroom. Teachers will find these projects to be lessons that are based on the NGSS standards and are grade-level friendly. All these projects incorporate the 4 C’s of Common Core, communication, collaboration, creativity and critical thinking. While teaching these skills is thought to be difficult by many teachers, by incorporating engineering design processes and the projects on this webpage, educators can safely attempt to cover the skills as they introduce STEM disciplines. I have made sure to note that these lessons require minimal preparation and minimal teacher guidance, since they each are focused on the goal to promote creativity and collaboration among students.
Grade K-2 Projects

The two Sample Projects on this page are for younger students in kindergarten through second grade who are being introduced to STEM and Engineering for the first time. These lower grades are often the best grades at which to begin STEM implementation because students are just beginning to learn about formal aspects of science and math, and can transfer their natural love of Nature to an interest for these subjects and how they are interconnected when properly taught.

The first lesson, *Rockets by Size*, incorporates both math and language arts and was created by NASA. It allows students to place in sequence the rockets by height, either tallest to shortest or shortest to tallest, and also allows students to compare and contrast the characteristics of the rockets. It is a simple lesson where all the required materials are provided and the procedure is given step-by-step. Students are able to color the rockets in whatever manner they choose and are given the opportunity to create a sentence describing the rockets. An extension for this lesson is also included for further exploration.

The second project on this page is *Structure Design for Lower Grades* created by Bryan Johnson (2014). In this project students are able to create a structure that is either the tallest or strongest in the class out of everyday materials. Some of the materials used could be plastic cups, straws, toothpicks, tape, marshmallows or sticks, depending on the grade level. Specific height measurements can be given, which should be shown for younger students who have not yet acquired the concepts of height and width. Students should be given examples of tall structures or strong structures as a precursor or mini-lesson to this activity and can find some structures of
their own to recreate. Again this lesson is very basic due to the grade level and NGSS standards.
The lessons on this page can be edited to each teacher’s preferences.

**Grade 3-5 Projects**

The projects on this page were created specifically for the upper-elementary grade levels. These projects can be completed with minimal support in small groups. Of course as mentioned before, teachers should be monitoring the process at all times and prompting if necessary. These projects can be a little more complex and require more working time than the previous two lessons, but can also be edited to the students’ abilities.

The first lesson provided is *Marsbound!* Created by NASA, goes through the engineering design process and allows students to create a spacecraft that would land on the planet Mars. Students are given specific information about the environment on Mars and specific constraints such as budget and material supplies. While completing this project, students are given an hour preparation time where they will be gathering data and information on data that is vital to the design of their spacecraft. They are then allowed another hour to design and build their prototype while collaborating with their peers and using their problem solving skills. Students are really taking the role of engineers in this activity by engaging in real-life problems or tasks and developing their learning dispositions (Costas and Kalick, 2015). This lesson includes the necessary hand-outs for students and the guide for educators.

The second lesson on this page is *Plant Growth Chamber* created by George Cordova (2014). This lesson is a little longer and broken up into five days. The purpose of this lesson is to promote students’ understanding of what life in outer space is like for astronauts. Students are able to view a webcam from outer space and see how astronauts live without fresh food. Students
are then given the task to create a plant growth chamber that would allow fresh food to be grown in space. Since this is an engineering project, of course students will go through the engineering design process that is shown in the How-To-Guide of this website, and take the role of engineers engaged in problem solving. This activity allows for student creativity and communication but also for continued discussion throughout the project. The five-day lesson provides questions for the students to review and answer as they move through their daily activities. It is a wonderful project because it incorporates many portions of STEM integration while also including Common Core and ELD standards.

The third and final project on this page for grades 3-5 is *Foam Rockets*, created by NASA and demonstrated by Dr. Ota Lutz, NASA Educational Specialist during the STEM Master’s Program Mathematics Seminar. The lesson requires students to create a rocket out of foam and launch it based on the appropriate angle desired. The construction of the rocket is very simple and easy to follow. The trajectory of the angle at launch is what can be difficult for some students. It is best if the teacher models the rocket launch first, before instructing students to do so; and showing them how their angles can be adjusted through their rocket launching technique. Again, this lesson can be difficult to understand if not first reviewed properly by the teacher and modeled for all students. Safety is a must for this project as launching it incorrectly can injure other students, so making sure expectations and classroom rules are reviewed often would be best. I chose to include this project because it allows students to engage in critical thinking and problem solving. If they aren’t reaching the angle required they must stop and analyze what they are doing wrong. There is no way should any students fail to learn, which is why I think it’s a great hands-on activity for this grade level. It is what STEM is all about!
Grade 6-8 Projects

In this final section of projects intended for middle school students, it is noted that these activities require more preparation time as well as an increase in student engagement since they can be complex. The first project included is *Building Structures* which was created by Bryan Johnson as was the lower grade *Building Structures*. This project is the same lesson altered for older students who have been exposed more frequently to STEM content. The purpose of this project is for students to learn about the engineering design process and the physical principles of buoyancy and displacement by working together to build a boat out of straws and plastic wrap that can hold 25 pennies for at least ten seconds before sinking. This activity requires more scientific knowledge compared to the lower grade *Building Structures* and also requires an understanding of buoyancy and displacement. This lesson is perfect for engineering and science integration along with some math.

The second lesson on this page is my very own *Next Generation Cars*. I created this project during my first semester in this STEM Master’s program. It is an activity that I started to do with my eighth graders when I first started teaching science. They loved the project and took it very seriously and it was this moment in teaching that I knew I needed to inform myself more about STEM integration. So this project is very important to me as an educator and future STEM leader. The purpose of this project is for students to design a next generation car that is constructed out of recycled materials and can run on air alone. Once they design the car they move onto the building stage where they must configure it using only the materials they listed. Of course after designing the car, students are able to test their prototype and decide whether they need to reconstruct their product due to any faults. This lesson is perfect when teaching the
engineering design process and it enables students to solve real-life problems. I have never had any problems when assigning this project.

The third and final lesson on this page is provided by Oscar Rios and is entitled *Robotics*. This project requires more funding than the other projects because it requires students to have Lego Education Robotic Sets to work on. The purpose of this lesson is for students to use LEGO’s Mindstorm NXT or EV3 in order to build robotic machines. Working in groups of three, they will learn that robotics is used for carefully-engineered constructions that make positive contributions to society. After they learn the basic construction techniques, they create their own robotic inventions with practical functions of interest to them. Again if teachers can secure grants or donations for a few of these kits, then the lesson will become a wonderful opportunity for students to work together. I have seen upper-elementary students working on these in Oscar’s class and the amount of maturity, level of engagement and collaboration among the students was unbelievable. I included this project because I truly believe that robotics is part of our STEM future.

**Resources**

This page was created for teachers who are looking for additional training in mind. While I thought it was important to create a resource page with articles and outside links, I already did that earlier in the project. So I thought it would be beneficial to create a page that included workshops that are offered through NASA/JPL for those educators who are eager to enhance their STEM knowledge, while also finding additional materials for their projects, and videos on how to read the NGSS standards. NASA/JPL (and all ten NASA Education Centers) workshops are amazing and usually send materials to your class that can be used in future lessons such as
they did with the Moon Rock workshop. These workshops usually fill up quickly and require reservations a month ahead of time. The workshops on this page will be updated monthly, as they add new ones throughout the school year. I hope to find other workshops in surrounding areas or districts that I can upload to this site in the near future. Again, this page is a work-in-progress and will require constant monitoring and editing as I work ahead towards bettering my STEM resources and materials.

The page that is titled, “How to read the NGSS Standards” includes videos from YouTube on how to read the Next Generation Science Standards and how to plan according to them. I think the hardest part of being introduced to the standards is not knowing how to analyze them or understanding what they want us to teach. So I thought including videos that showed teachers how to break apart the standards would be helpful and tie into the page where I included the links to the standards by grade level subsets. I remember when I first heard about the Next Generation Science Standards I felt so clueless and when asked to include them on assignment I had no idea of what I was to include. If I would have investigated a little more I would have found these videos earlier in my career and probably could have taught my first students a little more about engineering design. Then again as a teacher, I am a work in progress.

In the News

In order to provide our educators with concrete evidence of the importance of STEM and its purpose in the classroom, I created an “In the News” page. On this page the viewer will find three articles that I felt were the most influential in producing this project and three videos that will help to inspire teachers to begin implementing STEM in their classrooms if they have not done so already. The first article included is Appleton & Lawrenz (2011), Student and Teacher
Perspectives Across Mathematics and Science, which discusses how STEM should be meaningful to students and they should be able to relate to the content being taught. The second article of value is Bamberger & Cahill (2012), Teaching design in middle-school: Instructors’ concerns and scaffolding strategies, which discusses the importance of implementing engineering since it has been added to the NGSS standards. It also gives tips and guidance on how to begin incorporating it at the middle school level. The last article on this page is Nadelson, Callahan, Pyke, Hay, Dance, & Pfiester (2013), Teacher STEM perception and preparation: Inquiry-based STEM professional development for elementary teachers, which states that students are influenced very early in their elementary years and if given the proper STEM instruction will more than likely choose a career path that is focused on Science, Technology, Engineering and Mathematics. This article was the most important because it was the basis for this final project and website.

Aside from the reading material on this page, there are also a few videos that educators can watch in order to gain a little more insight on STEM. The first video provided by the Ohio STEM learning network is entitled STEM: The Thinkers of Tomorrow, and is basically an ad created in order to promote STEM. It was created as a message from the Ohio Education district to help promote the importance of STEM education. I think more of these ads need to be done and shown worldwide because they can open up a whole new world of thinking. The second video provided is entitled, Why STEM Education is Important, and was created by the Science Foundation of Arizona. It basically explains the significance of STEM education and its benefits to the state of Arizona along with the rest of the world. The last video provided on this page is, A STEM Education, Tools to Change the World, was created by the White House. This video explain how children can shape the world just by understanding science and math. This video is
probably the most important because it shows that the leaders of today feel strongly about STEM and we as educators need to do the same in order to make a difference in the world.

Blog

In keeping with the communication and collaboration theme of STEM, STEM Integrated Curriculum Resources includes a page where educators can follow STEM leaders and can connect and exchange information. On this page, teachers are able to leave feedback on the resources provided as well as ideas and tips for other teachers seeking to integrate STEM into their learning environments. Teachers are given the option to share these comments and topics on Twitter or Facebook for other people to view. Ultimately my goal is to reach out to others who are willing to implement STEM into their curricula despite not being formally trained, and continue an ongoing blog to update and inform all who visit the site. I want to help others who are interested in STEM implementation and give them a platform to start with. It isn’t about having funding or lots of time, it’s about making the most out of what you do have. We need to band together and prepare our students for their future by providing them with the skills they need in order to make the advancement towards meaningful careers.
CHAPTER FOUR: PROJECT WEBSITE

When developing a website that includes STEM resources for educators looking to implement this type of content into their classrooms, I chose to use the free website domain Weebly (www.weebly.com). Weebly was easy to use and included the editing tools necessary to create a meaningful website. Weebly allowed me to include links to outside resources as well as video clips and lesson plan documents. My goal throughout this entire project was to create an easy to use webpage for educators who are not formally trained in STEM. If teachers can look at my site and gain a little more knowledge on Science, Technology, Engineering and Mathematics then they had prior to visiting my site, my goal has been met. This website was created with the intention that educators would make an effort to begin implementing STEM into their daily curriculum. This will result in more diverse students from kindergarten through eighth grade to have the opportunity to engage in hands-on learning. STEM is the next big thing in education but many teachers fear what comes with it because they have little or no formal training in STEM integration. This website introduces teachers to what STEM is and how to begin implementing it gradually along with a few activities that are grade-level friendly.

I chose to create a website rather than a print resource guide because technology is a strong part of STEM and why should any of us fear it? It would have been easier to create a resource guide on paper but a website is more accessible to educators everywhere and updating the resources and activities is so much easier when using Weebly. The blog also allows teachers and anyone else who has visited the site to leave feedback and comments on any of the resources provided. Communication among other STEM educators is an important part of implementing STEM in classrooms and Weebly makes it possible. There are also options on the blog page where the topic can be Tweeted or shared on Facebook, both social media websites. These
options allow for my STEM website to be shared among other people aside from educators who may be interested in learning more about Science, Technology, Engineering and Mathematics.

Weebly is also a great tool that can be used by teachers, administrators and even students who have been introduced to the technology portion of STEM. The option to have many collaborators working on the site simultaneously would allow students to create a group site together as part of a STEM project. The easy editing tools make it simple to change font, background colors and template design. As many pages as desired can be inputted onto the website and each page can differ in design and content included. There are side-bar options that allow YouTube videos to be embedded, links to be inserted and pictures to be uploaded either from your own computer or search engines. Surveys and documents can also be uploaded by simply clicking one of the tabs on the left. The option to save content to one page or all pages included can be done by clicking save in the top right hand corner, as shown below.
After all the correct documents, videos and links have been uploaded to your Weebly site you have the option to publish your site to the World Wide Web. By doing this, anyone with access to internet can view your Weebly site and incorporate the resources you provided. Of course I doubled checked my site and allowed those close to me to visit my website in order to provide some sort of feedback before making it available to educators everywhere looking for STEM resources.

My website titled, STEM Integrated Curriculum is accessible at (www.stemintegratedcurriculumresources.weebly.com) includes many of the features offered by Weebly such as YouTube videos, hyperlinks, documents and pictures. The opening page welcomes visitors by showing pictures of my students working on engineering projects. Under the home link visitors can find some information about me as well as what STEM and Engineering implementation is. Next to the home link is the Incorporate Engineering into Your Curriculum link which again welcomes educators and leads them to the Getting Started page, Projects page and Resources
Getting Started page includes tips on how to begin implementing engineering into any classroom as well as the Next Generation Science Standards. The Project page is separated into 3 different pages which include projects for grades k-2, 3-5, and 6-8. Lastly the Resource page includes videos on how to read the NGSS standards and workshops that are offered for teachers of any grade level looking to increase their knowledge of STEM or simply get ideas from professionals. The In the News page contains articles on STEM studies and research and the importance of teaching it in early elementary school as well as middle school. There are also a few videos on why STEM Education is important and how it impacts our future. Lastly, the Blog page which I mentioned earlier, allows for educators to communicate and share their thoughts and ideas.

My hope is that local, state and national elementary school educators teaching will visit my website where they will find the resources provided useful and meaningful. It is my desire to update the information monthly and try to remain in contact with anyone leaving comments on the Blog page. I expect to make this website an ongoing project and influence other educators in the process. STEM is the future for our students and they need to be introduced to it in a positive manner as often as possible. I plan to locate additional lessons and resources to continuously add to this site so that it is updated, current and newsworthy. I hope that educators will add to this site by commenting on the blog and leaving ideas. Any resources, lesson plans or videos provided by visitors will be evaluated and vetted before being included.
CHAPTER 5: DISCUSSION AND IMPLICATIONS

My online Educator’s Resource guide explores ways to implement and integrate STEM subjects and most importantly engineering into elementary education classrooms. This online guide /website was created in order to provide educators who have not been formally trained in STEM with an accessible form of guidance on how to incorporate and regularly engage their students in science, technology, engineering and mathematics. The scholarly literature supports my stance that STEM is the future of our children and the foundation for many careers that await them. Students need to be exposed to all STEM disciplines at an early age in order to gain awareness, appreciation and understanding of their interconnectedness before they can advance in achievement at the high school level. In order for students to gain proper exposure to STEM material, teachers need to be given ample training and support because many are not yet been offered this type of training in teacher preparation or continuing education programs. This evidence supports my creation of this website. The Blog portion of the website addresses the collaboration component of STEM integration as well as Common Core and NGS standards for teachers, and is one of the steps that should be taken by educators when trying to implement STEM curricula. The Resources page of this site encourages constant growth among educators looking to better understand STEM and the Projects portion includes lessons for elementary grades kindergarten through middle school, which meets the principal goal of this graduate project. If these lessons are introduced during the grades as recommended, it is likely that, students will obtain a working knowledge of what STEM is and will understand it enough to pursue achievement in each of its disciplines.

In understanding the importance of student engagement in STEM, I made sure to include lessons that required student-led small group work. Whenever students are given a task to work
on with minimal support, most of the time they will complete the task appropriately and spend more time concentrating on the goal. Lecture and activities that are taught primarily by the teacher is not what STEM is about and this is why I made it clear on the opening Projects page that the lessons required minimal teacher support and were most successful when student led. This allows students to work on meaningful projects that invite them to solve real-life problems. Again this is the basis for STEM curriculum and I hope that my resources encourage other teachers to begin teaching projects in this manner.

As with any research project, there is never enough work that is done. Constant reformatting of lessons, standards and steps always need to be accomplished in order to improve teaching. We as educators are expected to align our professional practice with new or revised standards as now with STEM, we need to continue to advance, our pedagogy and content knowledge to assure success of our diverse students. This website is no different and should be updated regularly as more information and resources become available. My goal is for, “Stem Integrated Curriculum Resources” to continue to be an easy and accessible tool for educators and anyone else who wishes to learn more about STEM-integration and why it is important for our children’s and nation’s future. To explore \ STEM Integrated Curriculum Resources visit

REFERENCES


Berg, A., & Mensah, F.M. (2014). De-Marginalizing science in the elementary classroom by
coaching teachers to address perceived dilemmas. *Education Policy Analysis Archives*, 22 (57), 1-35.

Cordova, G. (2014). *Plant Growth Chamber*.


Wolf, S.J., & Fraser, B.J. (2008). Learning environment, attitudes and achievement among middle-school science students using inquiry based laboratory activities. *Journal of*
Research in Science Education, 38, 321-341.