Abstract
With the release of the Next Generation Science Standards and the intensive focus on boosting proficiency and interest in science, there are rising concerns that our schools are not in a strong position to meet these higher expectations for learning. The intent of this article is to examine current taxonomies used to design and deliver Science, Technology, Engineering, and Mathematics (i.e., STEM) curriculum in an effort to attract a greater variety of students to the STEM field of study in the school environment. The emergence of STEM curriculum in the educational system provides opportunities for all level learners to master skills and content important for 21st Century learning. Developing students’ reasoning skills, critical thinking skills, creativity, and innovation through integrated and connected STEM curriculum and pedagogical practices provides equity among learners from diverse backgrounds. STEM curriculum has the potential to provide true mastery for all learners.

I. INTRODUCTION
The paradox is that we live in a society where a lot of the careers that can be launched with a solid education in the STEM curriculum would seem to be appealing to the students who are failing to learn about them. " - Greg Tucker.

With the release of the Next Generation Science Standards and the intensive focus on boosting proficiency and interest in science, there are rising concerns that our schools are not in a strong position to meet these higher expectations for learning. Two significant barriers stand in the way of students engaging deeply with challenging content and the complex scientific method of collecting, analyzing and applying data. First, teachers are not
well-trained to guide students through the multilayered processes set forth in the new standards. Second, schools, especially those struggling to meet proficiency targets in literacy and mathematics, do not allocate sufficient time for either formal or informal science learning.

II. HOW STEM EDUCATION IMPROVES STUDENT LEARNING

Science, Technology, Engineering, and Mathematics (i.e., STEM) education has emerged as one of the most sought after curriculum designs for integrating science, technology, engineering, and mathematics into 21st Century education. It first became popular as a means of serving the needs of mathematically gifted students, providing opportunities to both accelerate learning and increase the rigor and depth of learning. Empirical studies have concluded that it is a strong enough factor to improve individual learning; however, learning activities where students practice using integrated skills to solve problems allow for deeper and more meaningful student learning. Originally, STEM education was directed at highly talented students (especially in Mathematics) and highly motivated students who were interested in exploring and learning a greater depth of material at a faster pace to practice strong reasoning skills and to develop and strengthen learning.

STEM education attracted a concentrated population until practices and methods were integrated into mainstream education and seen as opportunities to provide equity for motivated but disadvantaged students from a variety of backgrounds. Design and implementation of the curriculum infused with the four essential STEM subjects has produced a variety of teaching models and practices, making it difficult to evaluate program effectiveness. Some common educational practices include educational discovery as a form of problem solving, cooperative learning, and subject integration thus encouraging students to work together to design solutions to problems in a foundational and authentic environment using real-world data and problems.

Educators are eager to reduce performance gaps among particular ethnicities and socio-economically disadvantaged students by refining student skills. Moreover, learning activities are designed to focus on student engagement, knowledge acquisition, literacy analysis, synthesis, and critical thinking skills that will impact the depth of student learning. Many of the engineering principles and reasoning skills integrated into the STEM curriculum are promoted using existing learning models that are not newly developed but are newly modified. The STEM programs include powerful pedagogical practices centered on the student’s active learning, including cross-curricular integration, project-based learning, authentic and alternative assessments, writing literacy via research and reflection, creating partnerships with the business community, and solving or attempting to solve authentic, real-world problems. Students are learning and building skills that can be applied to a variety of situations, including making room for student innovation and original design.

Integrating engineering instruction and problem solving into high school mathematics and science courses connects curriculum to the real world, thus providing authentic purposes for learning and solving problems. Instructional strategies have been designed and
implemented to strengthen teachers’ efforts to facilitate engineering concepts and processes when students are learning science and math within an integrated learning environment. Science can be viewed as proposing explanations for questions about the natural world, whereas engineering proposes solutions for problems of human adaptation to the real world. Discovery, problem solving, and inquiry-based learning all play strong roles in STEM integration. Often students use cooperative learning to work in teams to research and complete tasks, to test theories, and to plan and implement processes and solutions. Learning is maximized because students share prior knowledge, play on one another’s best skills, and utilize one another for discovering new and important information. Learning practices can make learning more relevant because they can stimulate students as well as enable them to recognize links between their lessons and tasks performed by engineers in the real world. Teaching science and engineering in the integrated format also allows for other content areas to find places to integrate. Math teachers should plan and communicate with other teachers and with students to correctly time instruction for specific mathematics skills prior to needing specific skills for use in engineering or science instruction. Integrating social studies curriculum provides students opportunities to examine economic, political, and social issues that can directly or indirectly impact design decisions. Reading, writing, and speaking are important aspects of communication and should also play an integral role in curriculum alignment. Aligning the curriculum in this way helps students make purposeful and useful connections for math skills while they are building and practicing those skills in authentic learning environments, providing the learner with a clear lens to view the entire picture.

Inquiry-based learning is another learning model where the students become scientists in order to discover information. The National Science Education Standards highly recommend this instructional approach. Not only are critical thinking and reasoning skills explicitly taught using the scientific inquiry process, but students also personify what it is like to research, test, discover, and think like a scientist. Engineering becomes the active engagement students need to internalize learning by collaborating and creating solutions for real-world problems. Technology, science, and math are the tools; students must use to engineer their solutions. Literacy and writing are important for students to understand the history of previous attempts to solve problems. Speaking and communicating are essential for collaboration and persuasion. While STEM stands for the integration of science, technology, engineering, and mathematics, it really requires skills and knowledge from all content areas, including the arts. Design plays a significant role in engineering; one must be innovative, creative, and original when constructing authentic designs. Clearly knowing the science and math behind a solution is important, but 21st Century skills also call for innovation and creative design.

III. PEDAGOGICAL SHIFTS OF STEM

Traditional teaching methods will not support STEM instruction. The instructional models require students to be actively engaged in cooperative learning environments where
their instructors help facilitate creativity and inquiry learning. Rockland and colleagues suggest STEM instructors undergo professional development “aligned” and “designed to train teachers to use” integrated curriculum (Rockland et al., 2010). Several STEM curriculums have been aligned and designed to teach the integrated standards.

Students learn to program and build robots, exposing them to many science fields, including biology, medicine, engineering, and physics as well as information technology. There are other brands of robotics that can be used to integrate engineering and technology instruction into the teaching of science objectives. By integrating robotics, students are acquiring knowledge while refining their critical thinking skills. Students are afforded opportunities to learn science concepts in the hands-on environment, practicing and applying skills and knowledge. Students see and experience applied concepts and are better able to apply learned concepts to solve future problems and to transfer application to new situations. Teachers will need to develop an understanding for working with curriculum in order to better integrate and modify existing curriculum in the future. This can be seen when integrating Social Studies with engineering as students examine structures and technology manufactured by different cultures for varying needs in specific time periods. Merely writing engineering standards into curriculum will not necessarily improve or increase how it is being taught. Since engineering primarily focuses on problem solving and student-learning outcomes, the standards need to be integrated across all content areas at all levels of 21st Century education. Staff development and training are necessary for teachers to effectively integrate project-based learning with engineering concepts into the previously established learning objectives. An instructional framework “for pre-service teachers to blend engineering concepts” whereby the learner can more easily read, comprehend, and apply learning to all aspects of education. The “Preparation, Assistance, and Reflection (PAR)” framework suggests teachers pre-assess where students are in their background knowledge and skills before they begin exchanging ideas in a cooperative learning environment.

A significant role when integrating engineering into 21st century curriculum understands a student’s own interest. Providing choices and hands-on activities where students complete problem-based tasks such as building “transistor radios, burglar alarms, electronic timers, telephones, cameras, computers, robots etc. 

IV. ADVANTAGES OF INTEGRATING STEM CURRICULUM

The advantage of integrating STEM curriculum into all content areas at all levels is that it provides students with informal practice creatively solving problems. The opportunity to practice and understand engineering skills opens up a world of possibilities whereby students already have some experience and prior knowledge as to what their careers may be like. Using engineering design principles to complete hands-on, problem-based projects also deepens the student’s understanding of processes and emphasizes many of what we now call 21st Century Skills (e.g., collaboration, critical thinking, and interpersonal communication). Furthermore, STEM integration can become a seemingly typical part of the learner’s
educational experience on a daily basis, removing emphasis on gender lines and closing achievement gaps as students hone and master critical thinking skills.

V. CONCLUSION

The emergence of STEM curriculum in the educational system provides opportunities for all level learners to master skills and content important for 21st Century learning. Using a variety of activity-based learning models, students are provided opportunities to accelerate to rigorous depths of learning. Learning is facilitated so that students are encouraged to delve deeper into topics that interest them individually. Developing students’ reasoning skills, critical thinking skills, creativity, and innovation through integrated and connected STEM curriculum and pedagogical practices provides equity among learners from diverse backgrounds. STEM curriculum has the potential to provide true mastery for all learners.

VI. REFERENCES


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