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THOUGHTS FOR INTEGRATED STEM EDUCATION IN SCHOOLS

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I. INTRODUCTION

STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering, and mathematics in contexts 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.

The Idea of STEM education has been expected since 1990s in USA, as few teachers are looked to know that how STEM education is operationalize several decades later. As Americans realized that the country may fall after the global economy and began to heavily focus on STEM education and careers. In America there is an urgency to improve the achievements Science, Technology, Engineering and Mathematics education.

The Quality of Science, Technology, Engineering, and Mathematics (STEM) education is an important role for the future success of students. Integrated STEM education is one way to make learning more connected and relevant for students. Of-course there is a need for further research and discussion on the knowledge, experiences, and background that teachers need to effectively teach integrated STEM education. A support, teaching, efficiency, and materials (called as s t e m) model of considerations for teaching an integrated STEM education was developed through a year-long partnership with a school. The s.t.e.m. model is a good starting point for teachers as they implement and improve integrated STEM education.

The purpose of this paper is to describe factors that must be considered for teachers to effectively implement integrated STEM education. The information in this study provides recommendations for in general for integrated STEM education teachers. The research questions that guided this study are as follows:

1. What are the main considerations for teaching integrated STEM education?

2. For the school in this study what were the main factors that affected the teachers' implementation of the STEM curriculum?

II. THEORETICAL FRAMEWORK

There are various benefits that have been connected with the use of integrated education, Research indicates that using an interdisciplinary or integrated curriculum provides opportunities for more relevant, less fragmented, and more stimulating experiences for learners[1,,]. According to Fllis & Fouts[2], Some Other benefits that have been found are that it is student centered, improves higher level thinking skills and problem solving, and improves retention. Similar benefits have been found with a more specific focus on integrated STEM education. Several benefits of STEM education include making students better problem solvers, innovators, inventors, self-

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reliant, logical thinkers, and technologically literate. Studies have shown that integrating math and science has a positive impact on student attitudes and interest in school their motivation to learn and achievement.

The National Academy of Engineering and the National Research Council[3] (Katehi, Pearson & Feder, 2009) list five benefits of integrating engineering in K-12 schools: improved achievement in mathematics and science, increased awareness of engineering, understanding and being able to do engineering design, and increased technological literacy. With all of the possible benefits of integrated STEM education, it is important to determine how teachers can effectively teach integrated STEM education. Issues related to supporting teachers, teaching practices, teacher worth, and materials needed to implement integrated STEM education are dynamic to consider.

There is a growing number of institutions that are partnering with schools to support STEM education. Our school (BrainWorks K-12 Integrated School) has been working for over 2 years to integrate engineering into K-12 classrooms. They believe that engineering motivates students learning of the mathematics and science concepts that make technology possible. Professors, staff members, and students go into classrooms every week to assist teachers; they have monthly teacher support meetings, and training for teachers on technology resources. I found that in our school students not usually engaged in science were actively engaged in design process. The research on teaching integrated mathematics and science provides a good basis for teaching integrated STEM education. As Pang & Good[4] (2000), said that Successful integration of science and mathematics depends largely on teachers' understanding of the subject matter.

As Zemelman, Daniels & Hyde[5] (2005) gives top ten best practices for teaching math and science:

- use manipulatives and hands-on learning;
- cooperative learning;
- discussion and inquiry;
- questioning and conjectures;
- use justification of thinking;
- writing for reflection and problem solving;
- use a problem solving approach;
- integrate technology;
- teacher as a facilitator;
- Use assessment as a part of instruction.

Integrated STEM activities also allow teachers to focus on big ideas that are connected or interrelated between subjects. Berlin & White[6] provide recommendations on how teachers should approach student knowledge:

- build on students' prior knowledge;
- organize knowledge around big ideas, concepts, or themes;
- develop student knowledge to involve interrelationships of concepts and processes;
- understand that knowledge is situation or context specific;
- enable knowledge to be advanced through social discourse;
- Understand that knowledge is socially constructed over time.

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2.1 Teacher Efficiency within STEM Integration

Teacher efficiency is extremely important for successful teaching. Teachers' self-efficiency can be viewed as teachers' beliefs about their capabilities to produce a desired effect on student learning. Content knowledge and quality pedagogy play a large part in feelings of efficiency. As researchers note that a number of studies have pointed to the influence of teachers' self-efficiency beliefs on student achievement and success at school. In addition, teachers' feelings of self-efficiency have been found to be associated with enhanced student motivation, self-esteem, more positive attitudes in classes, and students' own feelings of self-efficiency. They also state that teachers' sense of efficiency is related to their satisfaction with their choice of profession.

2.2 Materials Needed to Implement STEM Integration

Integrated STEM education often requires numerous materials and resources for students to examine solutions to real world problems through designing, expressing, testing, and revising their ideas. Materials can include electronic materials such as computers, design programs, robotics kits, Pico-Boards, programming tools, Pop-sickle sticks, Electronic Playground kits, and other materials used in design, which could include glue, gums, cardboard, or construction paper. Through the use of these materials in design activities students can better understand technology. A broad definition of technology is anything that is human made that makes life easier. An engineers' job is to design technologies that can solve problems.

Integrated STEM education is an effort to combine science, technology, engineering, and mathematics into one class that is based on connections between the subjects and real world problems. However, in general, integrated STEM education can involve multiple classes and teachers and does not have to always involve all four disciplines of STEM. Engineering is becoming more prevalent in K-12 schools and can provide great problem solving opportunities for students to learn about mathematics, science, and technology while working through the engineering design process.

III. DISCUSSION

There are several implications from this article for administrators, teachers, and schools that are considering implementing a STEM integration program in our school continuing to improve a current program. Implementing effective STEM education requires dedicated, organized, and knowledgeable individuals. It is important to have teachers that are committed to being long-term STEM teachers and not just waiting for a math, science, or other job to become available. Teacher turnover can have negative effects for schools in terms of school cohesion, teaching effectiveness, and students' achievement. While teachers are developing their content knowledge of integrated STEM education, they can focus on quality strategies for teaching.

Since teachers may have different licensures and backgrounds, it is important for schools to provide support and time for collaboration. Our school used a variety of approaches to support teachers and encouraging open communication can help teachers to feel that they have the support they need to be successful. Mathematics, science, and teachers should try to collaborate to make sure that they are maximizing student learning. Similar concepts and information can be reinforced in classes or skipped if students have mastered the content.

IV. CONCLUSION

Much of the newest and most valuable knowledge involves more than one subject. Integrated STEM education can motivate students to careers in STEM fields and may improve their interest and performance in mathematics and science. Effective STEM education is very important for the future success of students. The preparation and support of teachers of integrated STEM education is essential for achieving these goals. Future research can focus on the development of curricula materials and instructional models for STEM integration, connections between teacher education programs for integration and teachers' subsequent classroom teaching practices, and also ways in which teachers view STEM integration. The s.t.e.m. model discussed here can serve as a starting point for teachers to be successful in facilitating student learning in STEM integration classes.

Teaching	
Lesson Planning	**Classroom Practices**
• Focus on connections • Understand student capabilities • Problem solving based • Build on Previous knowledge • Focus on big ideas, concepts or themes • Integrate technology • Real world and cultural relevancy	• Question posing and making assumptions • Justifying thinking • Focus on pattern understanding • Use assessment as part of instruction • Cooperative learning • Effective use of manipulatives • Inquiry
Materials Used	
• Technology resources • Broad view of technology • Materials kits for activities • Room space and storage for materials • Tables for group work	

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