Chapter 16
Use of STEM Intervention Teaching Scenarios to Investigate Students' Attitudes Toward STEM Professions and Their Self-Evaluation of STEM Subjects

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ABSTRACT

The present research initiated from the hypothesis that students' misconceptions can be resolved and replaced with new knowledge that is structured and organized through robust hypothetically-driven mental models. The assumption being that when students engage in teaching interventions that include hypothesis building and testing through STEM teaching scenarios and constructions, and are given the opportunity to discover the knowledge themselves, consequently, they enhance their attitudes towards STEM courses and career pathways as well as their own self-evaluation in mathematics and science. The quasi-experimental research methodology included a sample of 15-year-old students divided into an experimental and control group. The teaching intervention consisted of three scenarios developed primarily by the European Space Agency (ESA) but later adapted to meet the aptitude levels of students. Results showed improved attitudes in certain STEM courses and career pathways and a positive change in student's self-evaluations in science.

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INTRODUCTION

We live in a world that relies on technology and it is vital for young students to learn relevant skills for navigating an increasingly computerized society. Some of the necessary skills for the 21st century students are creativity, collaboration, critical thinking and problem solving (Trilling & Fadel, 2009). STEM is the acronym for Science, Technology, Engineering, and Mathematics that was popularized by educators, policy makers, and researchers in the early 2000's. STEM has become the buzzword in United States stakeholders where high school and college graduates prepare with new skills according to the aspects of STEM acronym in order to compete globally. Activities involving mathematics, science, technology and engineering have been proven to contribute to the development of these skills and at the same time increase the interests of students in the field of science and professions associated with STEM (Benitti, 2012). Learning in a STEM environment engages students how to learn about natural phenomena and engineering challenges via science investigation and engineering design, increasing their understanding of how the world works. Investigation and design are more effective for supporting learning than traditional teaching methods. They engage students in doing science and engineering, increase their conceptual knowledge of science and engineering, and improve their reasoning and problem-solving skills. In several educational systems, curricula have been developed focusing on research skills, problem-solving, critical thinking, creativity, innovation through disciplined teaching methodology (Kelley & Knowles, 2016) and embedding STEM programs with excellent results (English, 2016). Educators by introducing STEM interventions into their educational practices hope to increase students' interest in all aspects of STEM acronyms.

Unfortunately, many K-12 curriculum standards do not include the skills to introduce STEM interventions (Feldhausen et al., 2018). For this reason, the European Space Committee (ESA) has developed educational materials and STEM programs that are addressed to from pre-school students up to university students as it has been demonstrated by the literature that the contact of students with STEM programs has positive learning outcomes and cultivates skills necessary in the 21st century (Benitti, 2012; Verner & Revzin, 2017).

The current study looks at changes in Junior High School student attitudes toward STEM subjects after their engagement in programming, robotics and science-related activities and scenarios developed by the European Space Agency (ESA), and compares their attitude toward STEM career pathways pre- and post-intervention.

The authors attempted to answer the following three research questions:

1. When STEM-based activities are incorporated in teaching, to what extent do students' attitudes toward Mathematics, Technology and Engineering, and Physics change?
2. When STEM-based activities are incorporated in teaching, to what extent do students' self-evaluation in 21st century skills and attitudes toward science, health and environmental careers change?
3. When STEM-based activities are incorporated in teaching, to what extent do students' self-evaluation in Mathematics and Physics change?