An investigation into specific skills requiring enhancement in Qatari high school students to succeed in an engineering education

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ABSTRACT

Freshmen students at Texas A&M University at Qatar (TAMUQ), take a compulsory course called “Fundamentals of Engineering I”. It mainly focuses on five engineering principles: problem solving, analysis, design, team work and technology. An investigation of how science, technology, engineering and mathematics (STEM) are being taught in Qatari high schools was conducted to determine the limitations students have in the aforementioned principles. Surveys of students and teachers from eight Qatari high schools were conducted, and the teaching process was observed in the classrooms. It was detected that the most drawbacks in the investigated engineering principles were team work, design and use of technology. The purpose of this paper is to showcase the major results obtained from the surveys and observations. Possible solutions are suggested in order to increase the exposure of the Qatari high school students to the main engineering principles and hence make them better prepared for college engineering courses.

Keywords: engineering education, engineering principles, Qatari high schools

1. INTRODUCTION
Engineering is a field where mathematics and science are used to identify and solve problems using a highly creative design process. Industry leaders tell us that today’s successful engineers need excellent communication, problem solving, and life-long learning skills in addition to the technical content engineering educators have traditionally focused on.\textsuperscript{1,2} It was noticed that a large number of freshman engineering students at TAMUQ have a difficult time succeeding in the ENGR 111 course. To identify the major reasons that lead to these difficulties, an investigation on how Science, Technology, Engineering and Mathematics (STEM) material is presented to high school students in Qatar and how well engineering activities are integrated into the STEM curricula was conducted. Overall, this research is aimed at identifying the key skills that are required to enhance the capabilities of students and set appropriate learning objectives in the ‘Foundations of Engineering’ course.

2. METHODS
Four different forms of surveys were developed and used to gather data: Classroom Observation Protocol (COP) to observe both teachers and students in the classrooms, teacher demographic surveys to collect professional data such as the highest level of education, experience, etc.; teacher surveys to evaluate how the teacher conducted a lesson, and whether the teacher applied the SEC standards when conducting a lesson; and finally the student surveys to investigate students’ views about the surrounding learning environment and their teachers as well.

3. RESULTS
Overall results are illustrated in Figure 1, which show a poor implementation of key engineering principles in the high school STEM classes. It was noted that both students’ surveys and our observations (COP) agreed over analytical thinking results. For problem solving, design and use of technology a discrepancy is observed between what we observed in the classrooms and what student reported in their surveys. Team work, was rarely observed. For all skills studied teachers showed more optimistic results compared to ours and the students. All in all it was detected that the lowest percentages observed among all five principles investigated were team work, design and use of technology.

4. CONCLUSION
After investigating the application of different engineering principles, it was concluded that the high schools’ curricula in the STEM subjects needed major restructuring. The material presented in these subjects and the teaching methodologies used need to be reassessed to better integrate key engineering principles as they were not currently being addressed efficiently. The team highly recommends that the Supreme Council of Education do more research on the critical weaknesses that Qatari high schools’ students face and incorporate active learning experiences such as programming courses, hands-on experiments and learning experiences that will help build the students’ problems solving and analytical skills.

![Figure 1. Overall results from the COP and the surveys.](image-url)
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