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Growing a STEM Initiative: Establishing Philosophies, Identifying Needs and, Lessons Learned

Prof. Les Kinsler, Kansas State University, Salina

Les Kinsler is a Professor with the Engineering Technology Department at Kansas State University Salina campus. Mr. Kinsler received his M.S. Degree in Computer Science from Wichita State University (KS) in 1987 with an emphasis in Software Engineering. He received a B.S. in both Physics and Mathematics from Emporia State University (KS) in 1972. Mr. Kinsler teaches classes in programming, software engineering, and fluid mechanics. His research interests include embedded systems and controls as well as teaching methodologies.

Dr. Saeed Khan, Kansas State University, Salina

SAEED KHAN is an Associate Professor with the Electronic and Computer Engineering Technology program at Kansas State University at Salina. Dr. Khan received his Ph.D. and M.S. degrees in Electrical Engineering from the University of Connecticut, in 1989 and 1994 respectively and his B.S. in Electrical Engineering from Bangladesh University of Engineering and Technology, Dhaka, Bangladesh in 1984. Khan, who joined KSU in 1998, teaches courses in telecommunications and digital systems. His research interests and areas of expertise include antennas and propagation, novel materials for microwave application, electromagnetic scattering and wearable sensors.

Growing a STEM Initiative: Establishing Philosophies, Identifying Needs and Lessons Learned

Abstract

The momentum for promoting STEM education is on the rise across the country in unprecedented ways through educational grant offerings, student competitions, media coverage, and project oriented curriculums. Indeed, all are making positive contributions, but the need for more such programs in many school districts remains strong. This paper is an attempt at documenting the rolling out process of a STEM initiative in such a district where a needs assessment survey of area high school teachers and counselors came out in support of this endeavor. Analysis of the survey data made it immediately apparent that creating a STEM initiative that served as a pathway to higher education in the STEM fields would be well-received by the respondents. The collaborative STEM initiative was designed for a local high school and it consisted of a course designed to provide an introduction to high technology careers in science, mathematics, engineering and engineering technology. Through combination of lectures, projects, and shared experiences, students were to learn to differentiate between these fields. Students would also learn to make informed choices by listening to first-hand experiences that describe the rewards and demands in these areas. Starting with the basic design background, the authors will proceed to describe the two different renditions of this course and its evolution. Following an assessment review, the authors proceed to talk about future issues that will include discussion scalability and curriculum design.

Background

The importance of creating STEM pathways figured prominently in the early discussions centered on this collaborative endeavor. An important aspect of the deliberations focused on how best to deliver such a pathway and who was best suited to deliver it. Some key questions that arose at that time include the following: How appropriate are engineering technology faculty in delivering such an initiative? What form should it take?

Clues to answer the first question were found from a literature search and a survey of area high school counselors and teachers, community college technology program directors, career services liaison, four-year administration, and faculty. Observations of the survey data (Table 1) as reported in a 2010 paper[1] seem to indicate the respondents felt that their understanding of engineering/engineering technology (the ‘E’ and ‘T’ of STEM) as being lower than the understanding of Math/Science (the ‘S’ and the ‘M’ of STEM). <u>The responses seem to indicate that there is a greater need for the involvement by engineering/engineering technology programs in STEM education.</u>

Table 1: STEM Survey Data Summary

	OBSERVATION
1.	56 percent of respondents rated their overall understanding of STEM careers as being average or below average. This was 50 percent for science and math, 65 percent for engineering, and 69 percent for engineering technology)
2.	65 percent of respondents felt that creating pathways was very important or extremely important for engineering technology recruitment.
3.	52 percent of respondents thought articulation between high schools and four year schools was either important or very important form of STEM articulation.
4.	58 percent of respondents thought 3-tier articulation between high schools, two-year schools and four-year schools was either important or very important form of STEM articulation.

Furthermore, the data in Table 1 is supported by literature published in *The Bridge* journal from the national academy of engineers (NAE). The paper[2] discusses the problems associated with the implementation of technology/engineering standards in Massachusetts. The following extract from the paper in question can be seen to summarize some of challenges in implementing these standards.

> *"…the systematic implementation of technology/engineering standards in Massachusetts. Many technology education teachers were resistant to the change, causing a split in the state's technology education organization. One side was aligned more with the industrial arts-technology education perspective; the other with the technology/engineering- academic c perspective. Those who were watching this process, including school science staff, curriculum coordinators, and administrators, saw the unresolved conflict as a reason to delay the incorporation of technology/engineering concepts into school programs."*

This leads to our second question: What form should this initiative should take? From the previous discussion of the survey and related literature, a hybrid high tech careers course was one possibility. The course would consist of an online component of web lectures and face-to-face lectures and laboratory exercises. In this format, four-year engineering technology educators would teach technology/engineering standards to high school students. The STEM course offering was designed to help students make informed career choices in STEM fields. Four-year math/science educators would assist their engineering technology colleagues in providing enrolled students with an "*inside look at the rewards and demands of a STEM career through a combination of lectures and hands on experiences. Initial discussions with the school district officials seem to indicate a willingness on their part to facilitate this initiative by making this introductory course a part of their proposed STEM pathway. Qualified high school students will also be able to pick other existing four-year college STEM offerings as concurrent credit or dual credit.* "[1] Additionally, early discussions between collaborators resulted in a decision to try and include important soft skills as a part of this course. Along with the STEM disciplines, the course was to include competencies in global skills, teamwork, technical writing, and project management.

First Year Implementation

The first year implementation of the STEM program was ambitious, in that it involved faculty from both the Salina and Manhattan campuses. The campuses are 70 miles apart. The class sessions were held on the Salina campus. The STEM course was scheduled with cooperation of Salina South high school and involved only students from that school. It was decided that each week would showcase a specific area of STEM. Because of the many presenters, it was decided to standardize the format of the week. Each presenter was given the following format as were the high school students in order to standardize expectations of both the students and the faculty.

Class structure:

Thursday: Prior to the presenter's week of presentations and activities, presenters were to give students a reading or research assignment. The material could be from a website, physical text, periodical, or material posted to the STEM class's website. Suggested reading assignments included topics such as; an overview of discipline, notable people in the field, companies employing graduates in the discipline, or producing products created from the discipline, job titles, and career ladders.

Monday: Presenters were to post questions or short problems for students to work on during a class period held at the high school. All the students in the class were scheduled for a 50 minute period in the same room. They had computers available to the for internet access. Assignments could be completed individually or in groups at the discretion of the week's presenter.

Tuesday: Students attended class on the Salina campus for a lecture and/or activity. The presenter was introduced to the students by one of the lead faculty. The period was from 12:00 to 1:20 pm. It was suggested that the presenter provide an overview of the specific discipline and provide some activity to involve the students in interactive learning.

Thursday: Students again attended class on the Salina campus for a presentation and/or activity. After being introduced, the instructor was free to pursue the same or different applications within the discipline. It was suggested to presenters that the week conclude with a discussion of the discipline's unique contribution to society and the educational requirements for a career within the field.

Presenters Responsibilities beyond the assignments and presentations, each presenter was responsible for some gradable assignment for the week. The assignment was to be graded and returned to the students within 7 days. In order to even the grading across all the presentations, each week's assignment was valued at 100 points. A standard 90-80-70-60 grading scale was used for the class. Presenters were asked to limit assignments for the week to require a total of between 1 to 3 hours to complete.

Because of the distance between campuses, many of the presentations made by faculty from the Manhattan campus were done via Web and did not provide a true laboratory experience. The sessions given by the Salina campus faculty had a decided home-field advantage and allowed the faculty to schedule and use the Engineering Technology Labs to allow students to get some hands-on experience and application of the topics being explored.

Lessons Learned from the First Year

Unfortunately, we did not have a formal survey at the end of the course. The lead faculty and the students discussed the course at the end of the semester. Their comments also indicated that the students enjoyed the opportunity to apply the STEM topics to a real-life application and hands-on activity. The students also indicated that face-to-face presentations were of greater interest than the more lecture style non-interactive presentations given by distance. In most categories, the student group indicated that their interest in the STEM topics increased because of the course content. Overall, the students thought the course was worthwhile and that increasing the lab activities would make it more interesting to future high school students taking a similar course.

Second Year Implementation

The second rendition of the STEM course sought to preserve what appeared to work and correct what was either not sustainable or did not provide the results desired. The basic week's presentation structure was retained as it seemed to provide students the opportunity to do some research on the STEM topic on Monday and allow them to have both an informational and a hands-on session on the University's campus.

Learning from the first STEM class, it was decided to scale the class to a more sustainable format. The presenters were limited to the K-State Salina faculty. Each STEM topic had to include a hands-on activity on at least the Thursday class period. In order to provide a more in-depth opportunity for the STEM students, the Electronics and Computer Engineering topic was presented over 4 (non-consecutive) weeks. The Electronics and Computer Engineering sessions allowed the students to program a simple robot. The extended sessions provided the students an opportunity develop a presentation on robotics and the activities they enjoyed during the STEM class. At the end of the semester, the students gave a presentation to the high school's counselor, principal, and several staff. The high school staff were impressed by the students' enthusiasm toward the class and STEM in general.

Lessons Learned from the Second Year

The second year was much easier to manage from a lead-instructor point of view as the number of instructors was reduced and all were local to the campus. The addition of hands-on activities in each STEM topic provided additional interest by the students based on their participation and general attitude toward the material presented. The in-depth topic coverage provided the students a frame of reference that the STEM topics can be interesting but there are many concepts that must be learned before one can truly master a topic. The students were surveyed to determine if the course produced a greater interest and understanding of STEM topics.

Table 2: Before taking the course, how would you rate your ability to differentiate between, describe rewards, and understand demands of the following fields?

Topic	No Ability	Some Ability	Average Ability	Good Ability	Excellent Ability	Left Blank
Physics		2	2	1		
Chemistry			4	1		
Electronics & Computer ET			4	1		
Computer Systems Technology		1	2	2		
Mechanical Engineering Tech.		1	1	2	1	
Construction Engineering Tech.		2		2	1	
Math	1	2	1	1		
Digital Media		1	3	1		
Entrepreneurship			3	2		

Table 3: After taking the course, how would you rate your ability to differentiate between, describe rewards, and understand demands of the following fields?

Topic	No Ability	Some Ability	Average Ability	Good Ability	Excellent Ability	Left Blank
Physics		2		1	1	1
Chemistry		1	2	1	1	
Electronics & Computer ET			3	1	1	
Computer Systems Technology			2	2	1	
Mechanical Engineering Tech.			1	2	2	
Construction Engineering Tech.			1	2	2	
Math	2		1		2	
Digital Media			1	3	1	
Entrepreneurship				4	1	

Table 4: Before taking the course, how would you rate your interest in the following fields?

Topic	No Ability	Some Ability	Average Ability	Good Ability	Excellent Ability	Left Blank
Physics		3	1	1		
Chemistry		2	2	1		
Electronics & Computer ET			3	2		
Computer Systems Technology			3	1		1
Mechanical Engineering Tech.			2	2	1	
Construction Engineering Tech.		2	1	1	1	
Math	2	1	1			1
Digital Media		1	3	1		
Entrepreneurship			2	3		

Table 5: After taking the course, how would you rate your interest in the following fields?

Topic	No Ability	Some Ability	Average Ability	Good Ability	Excellent Ability	Left Blank
Physics		1	2	2		
Chemistry			3	2		
Electronics & Computer ET			3	1	1	
Computer Systems Technology			3	1	1	
Mechanical Engineering Tech.		1	1	1	1	
Construction Engineering Tech.		1	2	1	1	
Math	1		4			
Digital Media			4		1	
Entrepreneurship			3	1	1	

Table 6: Please specify the appropriate choice in each case.

Topic	Not Likely	Somewhat Likely	Likely	Quite Likely	Extremely Likely
Likelihood of going to an institution of higher learning (2 or 4 yr.)		2	2		1
Likelihood of choosing a STEM field			4	1	
Likelihood of starting college right after high school		2	2		1

Anticipated Future STEM course offerings

The basic weekly schedule will be retained as it is both effective and works well with the high school's schedule. The use of hands-on activities will be emphasized in each topic. The students seemed to enjoy the use of a major project spread out over several weeks so it will be retained. Projects will be considered that are within the scope of the high school student's abilities. Projects that cross over several STEM areas will be considered to emphasize to the students STEM areas do not exist apart from each other. The presentation by the students to an audience at their high school will also be retained as it provides a feedback mechanism to educate high school faculty and students.

Bibliography

[1] S. Khan, L. Kollhoff and M. and Kollhoff, "Finding Effective Pathways for Recruitment into Engineering Technology Program," in *American Association for Engineering Education (ASEE)*, Louisville, 2010.

[2] J. Foster, "The incorporation of Technology/Engineering concepts into academic standards in Massachusetts," vol. 39, no. 3, 2009.