QSCIENCE PROCEEDINGS

Engineering Leaders Conference 2014

Puzzles Principles and engineering education

Kamran Abedini

California State Polytechnic University, Pomona, CA 91768, USA

ABSTRACT

For this paper engineering programs were reviewed in terms of curriculum building and the technique of Puzzles Principles developed by the author is defined. This technique could not only enhance the teaching of capstone design courses, but generally could be incorporated in the design of curricula for effective engineering teaching. The concept of Puzzles Principles and its application can show how greatly engineering education can be planned and how the requirements suggested by the Engineer of 2020 can be implemented.

http://dx.doi.org/10.5339/qproc.2015.elc2014.77

QSCIENCE.com

An Initiative of Qatar Foundation

Cite this article as: Abedini K. Puzzles Principles and engineering education, QScience Proceedings (Engineering Leaders Conference 2014) **2015:77** http://dx.doi.org/10.5339/qproc.2015.elc2014.77

INTRODUCTION

Engineering education traditionally has been much segmented consisting of many courses being taught as independent subjects. There are times that a course is selected or defined as a prerequisite for others without genuine relation between courses or even minimal mention of relationships to others. Worse, review of programs has shown that often courses are taught without even mentioning their interactions with specific programs. The reader could automatically think about General Education courses (GE) when such problems are mentioned. However, the main problems noticed were the lack of relationship between core and support STEM type courses within the same department. If we are shaping and developing the engineer of 2020, then we have to change from the segmented teaching, look at the curriculum more from a "Systems" point of view and clearly show the interactions of courses as being taught. This means that while the professor is lecturing a subject, he/she has to be relating it to the next course, show why previous courses were pre-requisites, and then show how the subject is used by a professional engineer at job sites.

Additionally, to enhance the linking of courses and teaching engineering in general, the author believes that students should be looked at more as a whole person, capable of higher cognitive skills that we might currently expect them. Students are not to be looked at as robots, taking notes, listening, reading books and memorizing them and then show their intelligence by answering exam questions. Enhancing wisdom should be considered as we improve their intelligence. This is of special importance in a capstone course where if it is correctly designed, it should incorporate the essence of their education in engineering, and not only one or two subjects.

Based on the above arguments, the author developed the Puzzles Principles. A jigsaw puzzle consists of many pieces that make up a big picture, just like courses we put in a curriculum for an engineering program. When solving them, one looks at the main scene, divides the scene into sections, groups the pieces in sub groups (i.e. borders have straight edges), and although the pieces could be connected in subgroups, the relationship between the big picture, the segments and the pieces are still clear. Wouldn't that be nice if a freshman level student also was able to see the big picture from day one and the relationship between the courses (puzzle pieces) and any main subjects being taught (i.e. optimization) and also the big picture (i.e. any major in engineering)?

Furthermore, still keeping track of the concept of puzzles, at the very least capstone courses should be developed so that students use their wisdom to mainly define puzzles, and less emphasis on solving them (where they had already learned). For real life industry problems, professionals are always faced with puzzles and not homework problems. How should one solve the puzzle is more relevant than many situations that computer software can actually solve problems faster and one is only a data entry clerk. This basically means that wisdom in decision-making should be more emphasized than merely using intelligence to solve them. Here, an effective approach to problem definition is emphasized (looking at the big picture), then how big scenes could be divided in smaller sub-scenes, and then how to find the right pieces that belong to the sub-scenes. Once this activity is performed, not only solutions could be provided more efficiently, the cognitive skills used in engineering decision making are enhanced, leading to better and more creative engineering designs of products and processes.

The application of Puzzles Principles was developed as cases for the capstone course in Industrial and Manufacturing Engineering department at Cal Poly Pomona. In such cases scenarios were developed based on real industry situations and data (real or not) was provided without mentioning any reasons or questions. Students working in teams compete against each other to discover the main reason behind the case (the puzzle), provide problem statements, search and justify the best tools for problem solving, use the right data to solve problems, and provide solution for the puzzle, the main case, and not just the sub problems. All of this is simulated through a real scenario for which the recommendations should be provided within a limited time (usually a week), and just like real life only one team is chosen by the customer (the professor) as having the right solution fitting the customer's expectation. However, not like in real life, the losing teams fail, but they receive lower scores. Although a very rigorous and time consuming course, for the last several years of applying this technique, students have praised the course as the most valuable experience in their undergraduate education. The feedback from the Course Evaluations provided at the end of each term showed a very high level learning, at the exit interview almost all students praised the course as the one that gave them the confidence they needed to enter the job market, and lastly for Program Outcome assessment alumni expressed that although they may have used some of the subjects learned at school in their various jobs, they have mostly benefited from the experience of tackling the puzzles of the capstone course when they are faced with the day to day puzzles they face in the industry.

As the second phase of application of Puzzles Principles, the author is reviewing and redesigning the entire undergraduate industrial and manufacturing engineering curriculum as a systems analyst to ensure that the links become apparent, and in each course real life puzzles are introduced (the big picture), main problems are identified (a sub-scene), and the need of the specific subject is clearly defined (each piece of the puzzle), and then show why the puzzle piece or the course is needed for a specific part of the curriculum (Sr., Jr, etc.). A side benefit of this process for engineering students could be that they can embrace their profession and their assigned future tasks sooner and decide in a timely manner if they are fit with the job.