Using Patent Based Education as a Tool for Increasing Motivation and Teaching Know-why

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Abstract

Motivation appears to be a key factor in quality learning in higher education. Environmental factors such as lack of industrial base often kills intrinsic motivation of students and leaves only extrinsic motivation to be the only factor for forcing students to go forward with the curriculum. In an experiment we have conducted recently, we have found mixing patent related information to course contents not only increased intrinsic motivation of students but also benefited additionally by teaching know-why information to students. This paper summarizes our experiment and lists our final recommendations regarding which types of courses the method is beneficial and which type of patents should be selected for the most benefit.

1. Introduction

21st century is labeled as the age of innovation and engineers of this era are supposed to be entrepreneurial/enterprise engineers. According to Tryggvasson et. al [1], "the engineers of the new era expected to;

- Knows everything-can find information about anything quickly and knows how to evaluate and use the information. The entrepreneurial engineer has the ability to transform information into knowledge.
- Can do anything-understands the engineering basics to the degree that he or she can quickly assess what needs to be done, can acquire the tools needed, and can use these tools proficiently.
- Works with anybody anywhere-has the communication skills, team skills, and understanding of global and current issues necessary to work effectively with other people.
- Imagines and can make the imagination a reality-has the entrepreneurial spirit, the imagination, and the managerial skills to identify needs, come up with new solutions, and see them through."

Although the above description may seem too ambitious, internet era and easy access to information has forced the engineers to assume this new role with the above job definition as described. These requirements are indeed a tall order to fulfill, and students need to be motivated strongly toward achieving such a goal with limited number of courses squeezed into the curriculum. The performance demanded from 21st century engineers can be achieved only if the students learn the material well with quality conceptual learning rather than shallow learning. Problem now is how to motivate students to such quality conceptual learning. When we look at our classrooms, we see students who are not very enthusiastic about what they are learning. As Luechtefeld and Watkins [2] indicated, too many engineering students are passive and dependent learners, whose main interest seem to be "Will this be on the test?" According to Luechtefeld and Watkins, the underlying root problem of this type of behavior is the type of motivation used to push forward the student learning which emanates the very structure of our university education. It is obvious that in order to educate the engineers of the new era we need to find better ways of increasing motivation of students.

The problem of motivation is even more pronounced in educational institutions located in geographies where there is lack of industrial base. In such places, local companies often utilize engineers for service related operations; design related applications are rare. Knowing that design related problems are not likely to be encountered during their work, students tend to take some required courses of the curriculum lightly and pass courses with shallow learning just to get the degree. Design engineering is a skill that needs to be learned and practiced often to keep it honed and sharp. Although some of the graduates learn the necessary design skills in their workplace, most engineering students who graduate with such attitude toward design courses remain crippled for the rest of their career.

2. Importance of patents from know-why point of view

The ultimate aim of teaching a course is to give the students the ability to do something. Under the theme of ability there are two distinct issues; one is teaching *how* to do something and the other is teaching *why* it should be done [3]. Although both h*ow* and w*hy* are important to learning process, *why* seems to be more important than *how* in priority since learning why we do something triggers the curiosity of the students who will start finding ways of solving the *how* to part of the problem.

In our search for finding ways of increasing motivation of students and teaching know-why and know-how, we have experimented with using patents as a part of coursework. We have found the results of the experiment pleasantly surprising and decided to share our experience.

Literature search indicated that importance of patents in education has been emphasized by other researchers. McCorquotodale, in his article states that, "Intellectual property, is almost completely foreign concept to most students researchers" so he concludes that, it needs to be

taught just like any other course [4]. Wealth of information can be gathered from studying patents.

Garris, considers patent system as an essential tool for education of engineers [5]. Patents can be a very useful tool in engineering education. Patent databases should be used as a teaching tool more frequently in engineering education. It is almost forgotten that, patenting system is initially designed for the purpose of advancement of science and technology. Baldwin even warns about not using patents as a source of information saying, "It is dangerous for modern design engineers not to be familiar with the role of patents in a competitive industry" [6].

The constitution of United States of America initiated the patent system "To promote the progress of science and useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries;" [7].

2.1 Benefits of studying patents

Some of the benefits of studying patents can be listed as follows;

- Studying patents refines the design process. By studying case studies from patent databases, one can learn innovative approaches to problems solving.
- Studying patents give the idea of "know-why" which leads to understanding of intricate industry needs that leads to the particular invention. Every patent has a section on "background" which explains the need for the invention. Studying and understanding these needs is the first step in finding the solution.
- Studying patents leads to understanding of ethics, conflicts and infringements. By studying these concepts, students learn how to avoid litigations and learn about what is considered novel.
- Studying patents emphasizes the notion of innovation and financial benefits of innovation. After all, patent system is designed as an incentive to innovate. By learning financial benefits, students are encouraged to innovate.
- Studying patents encourage alternatives ways of design. To avoid infringing existing patents, inventors need to find alternative solutions to the problem. This process enlarges the scope of vision of students and encourages them to find alternatives.

3. An experiment in incorporating patents into a design course

COE 482, Soft computing, is senior level undergraduate elective course with 3-0-3 designation taught in Computer Science and Engineering Department of American University of Sharjah. Soft computing, by definition, refers to a collection of computational techniques used in

computer science, machine learning and some engineering disciplines, to study, model, and analyze complex operations. These computational methods are widely known as, fuzzy logic, neural networks, evolutionary computation, and swarm intelligence. COE 482 course concentrates on fuzzy logic and neural network part of the soft computing techniques. The course is taught in a computer lab where every student has access to a computer with appropriate Computer Aided Engineering (CAE) software tools installed. Computer aided engineering tools are software programs which lets user prototype a system or analyze using computers without going through the exercise of extensive programming.

In case of COE 482, these tools were special software packages to prototype fuzzy logic systems or neural networks using computers.

Desired student population of the course is 25 which is dictated by the hands-on nature of the course as well as number of stations in the lab. The purpose of the course is to teach soft computing concepts with particular emphasis on engineering applications. Soft computing is especially suitable for many interdisciplinary applications due to its linguistic-friendly approach. Typically, the course is taught by introducing soft computing methods one by one and then solving application examples using CAE software tools. The course has a project part, which is presented by students to class at the end of the semester. Students are typically grouped in teams of three members and the teams are assigned to individual projects.

The course is selected as a testing venue for implementation of constructivist approach to see if it s possible to seed spirit of innovation to students. The experiment was conducted in Spring 2007 offering of the course by modifying the project part to include patent based projects. In this particular offering, 28 students were enrolled in the course with 13 female and 15 male students. In this offering, it is decided to use fuzzy logic related patents as source of projects. Group of fuzzy logic related patents with interdisciplinary nature are selected by the instructor and groups are given choice to select the topic of their interest among them. All of the patents selected were recently issued patents with publication date of 2007 (current year of offering). Students were asked to study their patents, and implement the idea using the CAE tools that they have and present their working model at the end of the semester along with detailed explanation of the problem.

3.1 Objectives of the experiment

The objectives of the experiment were as follows:

1. Use the project part to increase the motivation of the students toward the course,

2. Change the teaching model of the course to embody constructivist principles,

3. Use “good undergraduate design course principles” to turn the course into a better engineering design course.

4. Use the course to increase awareness of students toward innovation in engineering.

3.2 Administration of the course

Major parameter used for the fulfillment of objectives is the project part of the course. Normally, the project part is administered in the last one third of the semester of the course, but in this experiment, the administration of the project started in mid-semester. Project part was started earlier than usual to in order to allocate sufficient time for fulfillment of objectives like increasing motivation toward the course. Since motivation is expected to be the key factor in success of the experiment, building up of motivation in early phase of the semester was desired.

Before the projects were assigned, students were given several sessions on how a patent document is organized. During the introduction particular emphasis placed on objectives of "Background", "Description" and "Claims" sections of a patent document. Each one of these sections provides valuable information toward fulfillment of the objective of the experiment.

"Background" section of patent introduces the problem that is being attacked by the patented invention. It also explains in detail current state of the art of technology. Since most project topics are of interdisciplinary nature, understanding the problem required careful attention to "Background" section.

"Description" section of patent contains the solution and approach of the inventor. Most engineering problems tend to be open- ended problems with no unique solution. This part of the patent shows the engineering approach taken by the inventor and can provide a valuable training in engineering. Since the project ultimately needed to be implemented using CAE tools, this part needed careful attention to extract application details.

Studying "Claims" section of patent is important since it contains information about how to protect the novel idea from possible infringements. Studying Claims part is also important to understand legal implications of not choosing appropriate words in writing the patent application.

Students are asked to form their groups and pick a project of their interest from a pool of patents. All patents in the pool were selected by the instructor as relevant to the topic of the course. Particular attention was placed to select patents with very recent date of publication. In this particular case, all patents are selected to be using fuzzy logic based in solving an engineering problem with publishing date of year 2007. Student groups were assisted extensively during the selection phase of their project. Instructor helped groups to identify an interdisciplinary subject of interest and select a patent accordingly.

After the assignment of projects, groups are continuously guided individually by the instructor during help sessions.

The groups presented their projects during the last two weeks of the semester. Their project grade is based on their presentation of their case and the quality of the model or solution they have constructed using CAE tools.

3.3 Titles of projects

The following patents are selected by student groups from the pool of patents selected by the instructor;

- Threat scoring system and intrusion detection security networks. U.S. patent number: US 2007/0169194 A1 [8].
- Method and apparatus for removal of heat in a refrigeration system. European patent number: EP 1 811 249 A1 [9]
- Patient ventilator synchronization using dual phase sensors. European patent number: EP 1 810 708 A1 [10].
- Novel intelligent search engine. U.S. patent number: US 2007/0050374 A1 [11].
- Method, apparatus and system architecture for performing handovers between heterogeneous wireless networks. U.S. patent number: US 2007/0115899 A1 [12].
- Wireless method and apparatus for monitoring food temperature. European patent number: EP 1 814 010 A2 [13].
- Ultrasonic grading of meat tenderness. WIPO patent application number: WO 2007/111712 A2 [14].
- Fuzzy logic based inverse treatment process. U.S. patent number: US 2007/0081629 A1 [15].
- System and method for fuzzy logic based fault diagnosis. U.S. patent number: US 2007/0078576 A1 [16].
- Elevator car dispatching including passenger destination information and a fuzzy logic algorithm. U.S. patent number: US 2007/0045052 [17].

The important aspects of selected patents and rationale behind selecting them are as follows;

1. All patents were recently granted patents (or applications) and they were less than one year old at the time of administration of the course. So students knew that, whatever they were studying was a recent innovation which fulfills an important need of the industry it is aimed for.

2. All patents involved novel use of fuzzy logic based solutions. Since the course specializes on soft computing, this gives an opportunity to see realistic engineering applications of the theory.

3. All projects were interdisciplinary in nature involving several branches of engineering. This is intended to emphasize the vast opportunities presented by interdisciplinary engineering problems. Fuzzy logic itself is not a new tool, but application of it to a cooling problem or to a problem like measuring tenderness of meat makes it an innovative solution to an engineering problem and deserves a patent.

4. Applicants of most patents collected in the pool were major corporations. Seeing these famous corporations as applicants of patents emphasizes the commercial value of the patent. This fact is intended to kindle the entrepreneurial spirit of students.

3.4 Survey results

The course evaluation survey that is conducted at the end of the semester and did not have any specific questions about the patent related project part. Due to the experimental nature of the approach, instructor has distributed two detailed additional surveys, which are focused on the patent project and effect of the project on outcomes of the course as well as kindling innovative spirit of students. One of the surveys was conducted before the final exam and the other one right after the grades are assigned.

Survey results, related to objectives of the experiment are as follows;

Objective 1: Increasing motivation toward the topic of the course.

To measure the response to this objective, students were asked questions that may relate partially to this objective by using the scale of, 1. Strongly agree, 2. Agree, 3. Neutral, 4. Disagree, 5. Strongly disagree;

- Question: Studying patents increased my understanding of fuzzy logic and soft computing. 85% of respondents agreed. Response is given in Fig. 1.

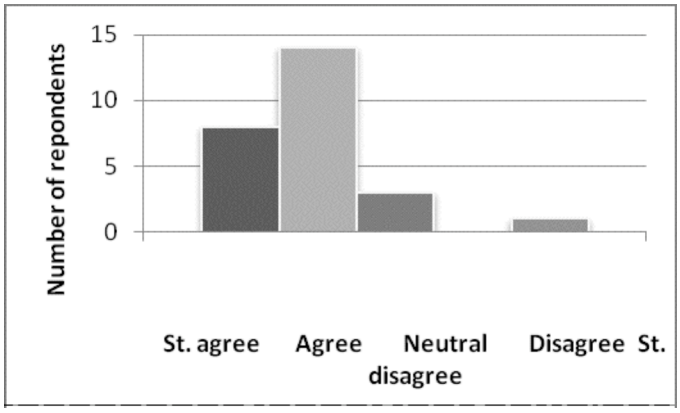

Fig. 1 Effect of project on understanding the topic

- Question: Instructor's teaching method made it easy to follow lecture and helped my understanding. Response is given in Fig. 2. 78% of respondents agreed.

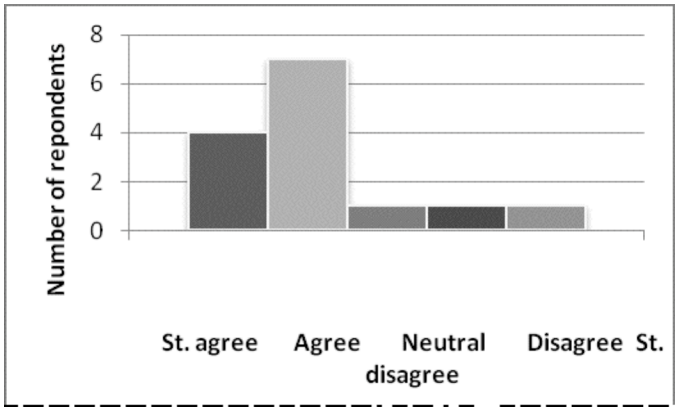

Fig. 2. Evaluation of teaching method

Objective 2: Constructivist approach through realistic case studies

Students were asked to respond to;

- Question: The project showed me that soft computing techniques can be applied to everyday procedures to get patents. 88% of respondents agreed.

- Question: Did studying the patents made you understand the fuzzy logic concepts better? 80% of respondents agreed.

Objective 3: Use of good undergraduate course design principles

Students were asked to respond to:

- Question: I find the patent related project interesting. 92% of respondents agreed.
- Question: Overall, I find the project useful for the course. 85% of respondents agreed.

Objective 4: Increase awareness of students toward innovation

Students were asked to respond to;

- Question: The project has given me idea how to innovate new products. 77% of respondents agreed.
- Question: The project has kindled my interest in applying for patents in case I come up with an innovative idea. 65% of respondents agreed.
- Question: The project gave me idea about how to write a patent in case I have to. 61% of respondents agreed.
- Question: After studying patents, I find patenting products easier than I taught. 73% of respondents agreed.

4. Suggestions regarding applicability of the method for other courses

The experiment we have conducted was for a specific course and there is no way we claim that it would work for every subject. However, based on our experience we can make the following recommendations regarding applicability of the method.

- In our opinion, teaching through patent approach is best suited for mature audience, e.g junior/senior students would benefit more than freshmen and sophomores. (Although, it would be very interesting to see the affect of giving this notion early in the curriculum.)
- For the best impact, classical textbook approach should be enhanced with patent related approach. Classical textbook approach is good for giving the basics of theory; patent approach shows the students how to think “out of the box”.
- For the best impact, patents with recent publication dates should be selected for study. Patents with extraordinary approach are suitable regardless of their publication date.
- Even though we have conducted our experiment without telling our students in advance that patent approach will be used, in our opinion, giving information about the patent approach in advance may be beneficial by triggering the curiosity of the students.

- Courses that deal with contemporary issues are probably the best candidates for patent oriented teaching approach.
- Courses with mature content may benefit from the patent oriented approach if the course material can be compounded with some patents that show "out of the box" approach.
- If a student or a group of students generate ideas worthy of patents during the administration of the course, this would kindle the interest of students even further and may be very beneficial for motivational purposes.

5. Suggestions for adapting patent based learning to E-learning environment

Patent based learning technique is experimented in a face-to-face teaching environment; however, in our opinion the technique has great potential to be adapted to E-learning environment. Our suggestions regarding adapting the techniques to E-learning environment is as follows;

- Patent related case studies can blended through the whole course or can be lumped toward the end of the course. Blending case studies to the course at appropriate times may give the best impact.
- A suggested way for incorporating patent study to the course may be as follows;

    1. During the delivery of the course, at a suitable point when student has the necessary background, a "case study" can be injected without mentioning anything about the patent.
    2. Using the background information given in the patent document, current state of the art is conveyed to the student using text or rich media. (Video, game setting, audio etc.)
    3. Using the information provided in background part of the patent, current problem that needs to be solved is conveyed to the student using text, or rich media. At this point it would help to put a price tag on the worth of the answer with a statement like ".. for a solution worth 1M$ …." to kindle interest of the audience and student is invited to find a solution.
    4. At this point, students should be encouraged to search for a viable solution on their own with reasonable time allocated for providing answer.
    5. After the submission time is over; possible answers should be evaluated with cost and complication considerations. This may be done by the instructor in a face-to-face setting, or in a distance learning setting it may be done through evaluating a series of possible answers with their shortcomings.

6. The solution suggested by the patent is presented at the end of the case study using text or rich media along with the information about the patent, like number, publication date, owner information etc.

Providing several cases this way could provide a very rich learning experience for the students. Evaluations of the students' submissions for possible solutions at stage 5 listed above should be done carefully and the intention of evaluation should be encouragement rather than ridiculing the answers. It is our experience that sometimes odd-looking solutions can provide excellent solutions and it is very likely that one of the solutions may actually better than the solution provided by the patent.

6. Conclusion

An experiment is conducted with senior level students of computer engineering department who were registered for the Soft Computing class for the purpose of exploring patents for teaching purposes. The students were neither exposed to patents before nor had any expectation of learning about patents when they have registered for the course. We introduced the idea of "using patents as a learning tool" to such an uninitiated audience and observed their responses are measured their reactions using surveys.

The survey results indicated that majority of the students found using patent based project for teaching the course interesting and relevant to the course. The project has made them aware of the interdisciplinary nature of fuzzy logic and its applicability to wide range of engineering disciplines. Seeing wide range of applications and up-to-date nature of patents increased their motivation toward the subject.

The results also indicated that majority of the students liked the idea of using patents for case study and benefited from the approach. A couple of students verbally commented that this process has initiated their interest in innovation and few of them felt confident that they can generate ideas and attempt getting patents.

After the completion of the course, instructor has received several inquiries from students regarding their novel ideas about computer related designs and products. Even though the designs were not related to fuzzy logic, it still indicated a kindled interest of students toward novelty.

As a conclusion, the surveys and the observations of the instructor indicated that patents could be very useful tool in teaching relevant course subjects as well teaching engineering design process.

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