Using Patents as a Tool for Reinforcing Constructivist Learning Environment in Engineering Education

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***Abstract*—**One of the senior year elective courses that is taught in Computer Science and Engineering Department has been modified in such a way that, the projects assigned in the course are based on recently published patents rather than classical textbook type projects. The intention of the experiment was twofold: to observe the change in the motivation level of students through this change and to observe the effect of shifting emphasis from instructive to constructive approach. According to Self-determination theory of learning, as the motivation of the course gets shifted from extrinsic motivation to intrinsic motivation, students get more benefit of the course. By the changes implemented, collaborative and constructivist approaches are applied to the course and motivation level of students has been increased. The paper explains the methodology of selecting patent topics, the way course is administered and the results of the survey.

***Keywords*—**Engineering education, Patents, Technological innovation, Constructionism Collaborative learning, Educational technology, Self-determination theory.

I. Introduction

MAJORITY of the economists agree that, with the globalization and information technology revolution that took place in the 20th century, the rules of the game for economic growth have changed. Now, intangible resources like knowledge and know-how become the coal, oil and diamonds of the last century for developed, developing and emerging economies [1]. In this century, innovation capability and innovations are considered the most valuable assets that a country can have [2].

Many claim that engineers are the leaders of this change, and nations need to generate engineers with innovative ideas and entrepreneurial spirit [3]. With the enormous emphasis on "innovation", engineering education needs to find new and alternative ways of integrating spirit of innovation and entrepreneurship into existing engineering curriculum. Many institutions have adapted different ways of incorporating invention, innovation and entrepreneurship into their curriculum [4]-[11].

Many educators suggest that, the innovative spirit needed in engineering students has to be given through design courses which place emphasis on multidisciplinary concepts. In a paper published by Bjorklund and Cobeck, a survey conducted among the top engineering education leaders indicated that one of the top goals in engineering education should be "… incorporation of design in engineering curricula, focusing on the practice of art and practice of engineering, and not just engineering science" [12]. Another top goal emerged in the survey is stated as "… the need for broad-based curricula: curricula that are integrative and interdisciplinary within engineering and curricula that incorporate non-technical or softer elements of engineering". All of these and many other studies in literature emphasize the importance of using interdisciplinary subjects and design for proper engineering education.

The process of imparting innovative sprit to engineering students is not an easy task. As Kamp states in her study, incorporating high goals into curriculum takes specialized courses as well as relevant changes in many courses contents [13]. Stating in a different way, it takes not a single course but a concerted effort of many individual courses to give the spirit of innovation and entrepreneurship to students.

The purpose of this study is to report the results of an experiment conducted in a specific engineering course. In this experiment, parts of the course are modified in a way to affect the motivational aspects of the course. The changes introduced also intended to sift weight from instructional to constructivist nature. With all the changes implemented, the course is expected to increase the innovative spirit of students as well as improving the "engineering design" aspect of the course.

II. The Importance of Patents in Engineering Education

The question arises about the methodology that needs to be followed for incorporating innovation into engineering design courses. This present a challenge since most engineering problems are "open-ended", the best solution to the problem changes with time and the available technology. Under these circumstances selection of the appropriate method for tackling the problem is an important issue.

One of the approaches to solution of the stated problem is through "studying patents" in relevant courses. Wealth of information can be gathered from studying patents.

Manuscript received December 3, 2008.

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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 [14].

Patents can be a very useful tool in engineering education. Patent databases should be used as a teaching tool more frequently in engineering education. Garris, considers patent system as an essential tool for education of engineers [15]. 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" [16].

A. Impact of Patent on Science and Technology

Nard and Moriss [17] has conducted a detailed study of patents which states that patents were first constitutionalized in medieval State of Venice by ground breaking Venetian statute of 1474, which is accepted as the first modern patent system. This was followed by Statute of Monopolies established by British in year 1624 which is similar to patent law. Lastly, it was adopted by founders of U.S constitution by incorporating Article I, Section 8, Clause 8 of the Constitution which states "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;" and establishes the existing patent system [18].

Establishment of patent laws has caused increase in scientific and technological breakthroughs and welfare in all these countries. Medieval Venice is known to be one of the most industrialized and crowded city in Europe with very impressive ship building capacity even in today's standards. Patent system is one of the likely forces behind industrial revolution which catapulted British at the times. Finally, the strategy of constitutionalization of patents has certainly worked for United States of America successfully as well and caused science and technology to flourish.

Based on the historical analysis, Nard and Moriss derived the following three desirable features of patenting system [17]:

"(1) Strong constraints on the type of patents that can be issued, limiting them to areas in which there is evidence that the costs of the limits to competition imposed are justified by the benefits produced by the incentives created;

(2) An independent institution capable of reviewing the grant of a patent in a timely and final manner, to ensure the constitutional bargain is kept; and

(3) Patents that provide their owners with a sense of security in the validity and scope of their property right, to maximize the value of the bargaining chip offered to inventors."

B. Benefits of Studying Patents

As it is proved to be such an effective tool in establishment of science and technology, there is need to study and incorporate patents into engineering courses. 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 possible infringement on 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.

III. 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 extensive exercise of 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 at the end of the semester. Students are typically grouped in teams of three members and the teams are assigned 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, instructor has 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 which was the current year of offering of the course at the time. 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. Instructor has provided help at different phases of the experiment about how to read patent documents, about patent language and technical contents of patent documents.

IV. Objectives of the Experiment

The objectives of the experiment were as follows:

1. Use the projects to increase the motivation of the students toward the course and the topic,
2. Change the teaching model of the course to embody more 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.

These objectives are explained in detail in the following sections.

A. Increasing Motivation

Psychologists state that human behavior is influenced most by motivation. Self Determination Theory, (SDT), is a theory developed by Ryan and Deci [19] and states that motivational states of human beings range from "amotivaton" to "intrinsic motivation". Amotivation is an extreme state where there is total lack of motivation and intrinsic motivation is another extreme state where the subject is totally motivated toward a goal. These two states are called extreme states and they are rather rare, in between there is the state of extrinsic motivation which means being motivated by external means. Self Determination Theory states that the best possible sort of motivation for human beings is intrinsic motivation where the person is motivated not due to external regulatory factors but totally because of his/her belief in benefit of the cause [18]. Amotivation and intrinsic motivation are two extreme cases of motivation. Extrinsic motivation, which is in between these two extreme states, is divided into several stages in itself. External regulation is a stage of Extrinsic motivation which is closest to Amotivation and Integrated regulation is a stage of Extrinsic motivation which is closest to Intrinsic motivation. Introjected regulation and Identified regulation are varying nuances of Extrinsic motivation with increased motivation. The stages of motivation according to SDT are shown in Fig. 1.

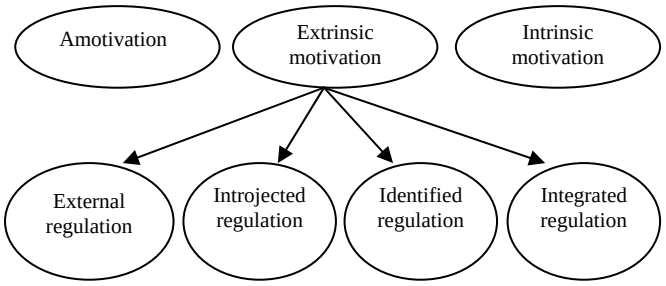

Fig. 1 levels of motivation of students according to Self Determination Theory (SDT)

In most cases, students' motivation toward a course ranges in the category of extrinsic motivation. SDT states that lowest category of Extrinsic motivation is External regulation where the person does what he does due to forced regulations. In the case of students this means taking the course only because it *has to be taken* to graduate. External motivation categories improve as students believe in the benefits of the course and take it not only because it is required for graduation, but it is also good for their future. Best motivated division of Extrinsic motivation is called Integrated regulation where student take the course with desire and expectation that he/she will definitely benefit from the course.

Our earlier observations with the course indicated that, motivation level of most students who take the course (or any other elective course) mostly fall into the category of External regulation with few in Introjected regulation category of Extrinsic motivation. In other words, students take the course not because of the benefits that they will get but because it was another course to fulfill required credits toward graduation. Few were curious about learning more about soft computing because of the publicity around fuzzy logic. One of the primary objectives of the experiment was to upgrade the motivation level of the students toward the course and make it more desirable for the students. According to the theory of SDT, if students have higher degree of motivation they will get more benefit of the course.

B. Higher Degree of Embodiment of Constructivist Teaching Philosophy in the Course

Educational researchers have studied methods of teaching and learning to figure out best ways of teaching. Extensive studies by cognitive psychologists and educators has contributed to establishment of theory called "Constructivist Learning" theory which is mostly being practiced today [21]-[23].

Jonassen has summarized the principles of Constructivist Learning Environment as follows [21], [24]:

"1. Create real-world environments that employ the context in which learning is relevant;

2. Focus on realistic approaches to solving real-world problems;

3. The instructor is a coach and analyzer of the strategies used to solve these problems;

4. Stress conceptual interrelatedness, providing multiple representations or perspectives on the content;

5. Instructional goals and objectives should be negotiated and not imposed;

6. Evaluation should serve as a self-analysis tool;

7. Provide tools and environments that help learners interpret the multiple perspectives of the world;

8. Learning should be internally controlled and mediated by the learner."

In other words, constructivism is the philosophy of teaching by presenting natural complexity of real world by focusing on knowledge construction rather than reproduction. An important concept of constructivism is called "scaffolding" where student is guided to learn by receiving help from instructor [24]. In "scaffolding", knowledge is built up by building over what student knows adding knowledge part by part.

Constructivist concepts and scaffolding is already practiced in most courses. In fact, some of the rules, regulations and guidelines developed and enforced by engineering accreditation organizations can be traced back to these philosophies. One of the goals of the experiment is to increase the constructivist content of the course. Patents appeared as very powerful tools for constructivist learning with scaffolding approach. By studying to real life patent cases we intended to implement most of these design principles very effectively during the administration of the course.

C. Use Good Undergraduate Course Design Principles to Make Course Better

What makes an undergraduate course a good undergraduate course has been studied by Chikering and Gamson and the findings are summarized in seven design principles [25]. These principles are listed as follows [26]:

"1. Encourages contact between students and faculty

2. Develops reciprocity and cooperation among students

3. Encourages active learning

4. Gives prompt feedback

5. Emphasizes time on task

6. Communicates higher expectations

7. Respects diverse talents and ways of learning"

One of the objectives of the experiment was to make the course a better undergraduate course through fulfillment of the design principles stated above. Although the basic principles were already satisfied with the course, patent based projects expected to communicate higher goals, encourage active learning more and requires more contact between faculty and students. These changes are ultimately expected to make the course better.

D. Increase Awareness of Students Toward Innovation in Engineering

Another one of the major objectives of the experiment was to increase the awareness of students toward innovation and see if it is possible to seed innovative sprit to students through studying real- life, real-time innovative examples.

V. Administration of the Course

Typically the course is administered by introducing individual concepts followed by CAE based design and development exercises conducted in the lab. As an example, fuzzy logic concepts are introduced in class followed by CAE based design examples. Same way, neural network concepts are introduced in class followed by CAE based design examples conducted in the lab. Typically, at the end of the semester, a sizable project is given which requires student to combine and apply everything that he/she has learned so far in the course.

This part of the project where the end of semester project is assigned has been mortified to incorporate patent based projects. Normally, the project is administered in the last one third of the semester of the course, but in this particular experiment, the assignment and administration of the project started in mid-semester. Project part was started earlier than usual 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 highly desired.

Before the projects were assigned, students were given several sessions on organization and parts of a patent document. 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 the 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 design" education. 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 in advance from patents that are 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 soft computing-based solutions to an engineering problem with publishing date of year 2007 (year of offering). The idea behind selecting recently published patents is to increase the motivation of the students by showing the relevance of the topic to modern day engineering problems.

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 continued to be 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.

A. *Titles of Projects*

The following patents are selected by students 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 [27].
- Method and apparatus for removal of heat in a refrigeration system. European patent number: EP 1 811 249 A1 [28]
- Patient ventilator synchronization using dual phase sensors. European patent number: EP 1 810 708 A1 [29].
- Novel intelligent search engine. U.S. patent number: US 2007/0050374 A1 [30].
- Method, apparatus and system architecture for performing handovers between heterogeneous wireless networks. U.S. patent number: US 2007/0115899 A1 [31].
- Wireless method and apparatus for monitoring food temperature. European patent number: EP 1 814 010 A2 [32].
- Ultrasonic grading of meat tenderness. WIPO patent application number: WO 2007/111712 A2 [33].
- Fuzzy logic based inverse treatment process. U.S. patent number: US 2007/0081629 A1 [34].
- System and method for fuzzy logic based fault diagnosis. U.S. patent number: US 2007/0078576 A1 [35].
- Elevator car dispatching including passenger destination information and a fuzzy logic algorithm. U.S. patent number: US 2007/0045052 [36].

B. *Important Points About Selected Patents*

Some important points about selected patents and the rationale behind selecting them are as follows;

1. All patents were recently granted patents and they were less than one year old. So students know that, whatever they are studying is a recent innovation which fulfills an important need of industry.
2. All patents involved novel use of fuzzy logic or neural network based solutions. Since the course specializes on soft computing, this gives an opportunity to see realistic engineering applications of theory.
3. All projects are 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 a solution to an engineering problem and deserves a patent.
4. Applicants of most patents collected in the pool were from 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.

VI. Survey Results

The regular course evaluation survey which is conducted at the end of the semester did not have any specific questions about the patent related project part. Due to the experimental nature of the approach, instructor has distributed an additional survey which is focused on the patent part of project and effect of the project on outcomes of the course.

Survey questions and results are as follows;

Question #1. I find the patent related project interesting. 92% of the students agreed. The distribution is shown in Fig. 2.

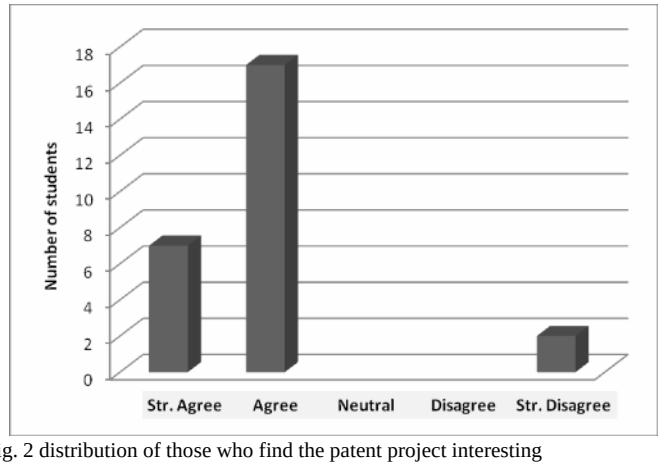

Fig. 2 distribution of those who find the patent project interesting

Question #2. I think the project was relevant to the course.

76% of students agreed. The distribution is shown in Fig. 3.

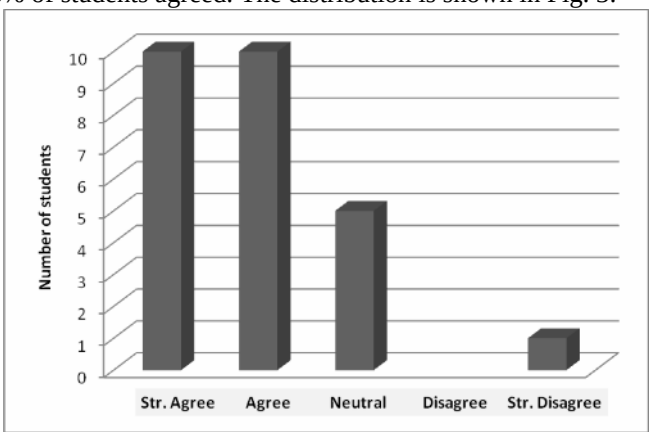

Fig. 3 relevance of the patent project to the course

Question #3. The project showed me that the soft computing techniques can be applied to everyday procedures to get new patents. 89% of the respondents agreed. Distribution is shown in Fig. 4.

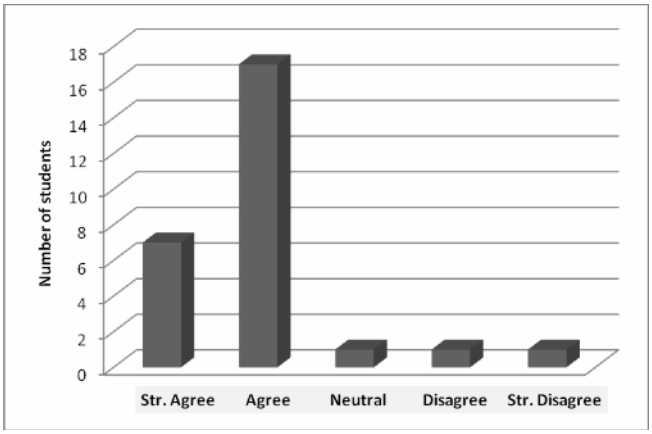

Fig. 4 relevance of soft computing to contemporary problems

Question #4. Studying patents increased my understanding of fuzzy logic and soft computing. 85% of students agreed. Distribution is shown in Fig. 5.

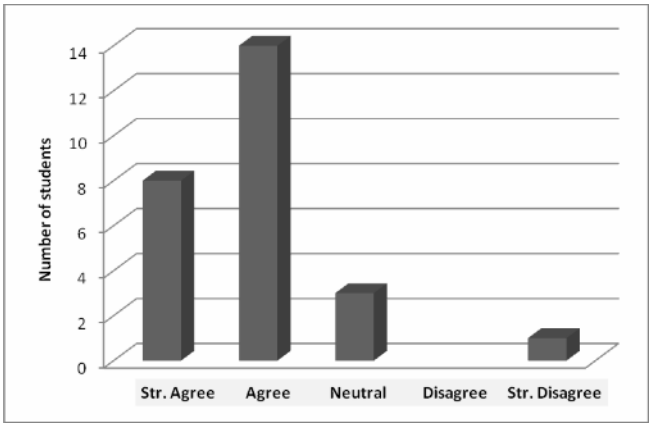

Fig. 5 studying patents increased understanding of soft computing

Question #5. The project has helped me to understand the patent language and the patent procedure. 73% of respondents agreed. Distribution is shown in Fig. 6.

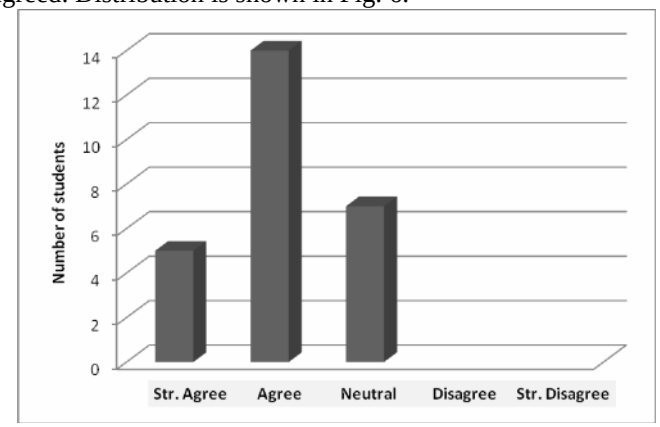

Fig. 6 understanding of patent language

Question #6. Learning about patents, how it is written was interesting. 80% of students agreed. Distribution is shown in Fig. 7.

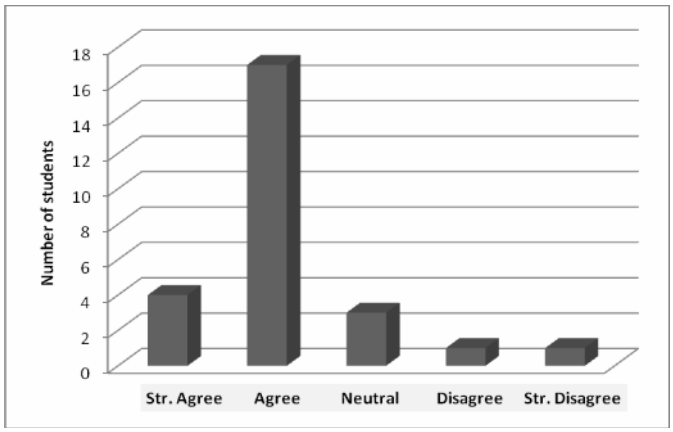

Fig. 7 learning patents is interesting

Question #7. The project has given me idea how to innovate new products. 77% of students have agreed. Distribution is shown in Fig. 8.

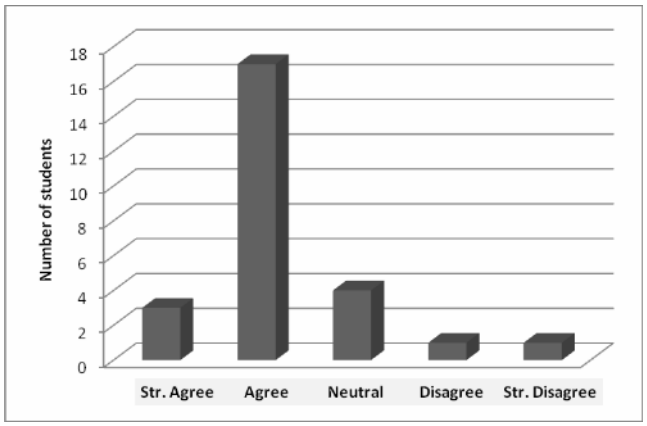

Fig. 8 project has given idea how to innovate

Question #8. The project has kindled my interest in applying for patents in case I come up with an innovative idea. 65% of the respondents agreed. Distribution is shown in Fig.

9.

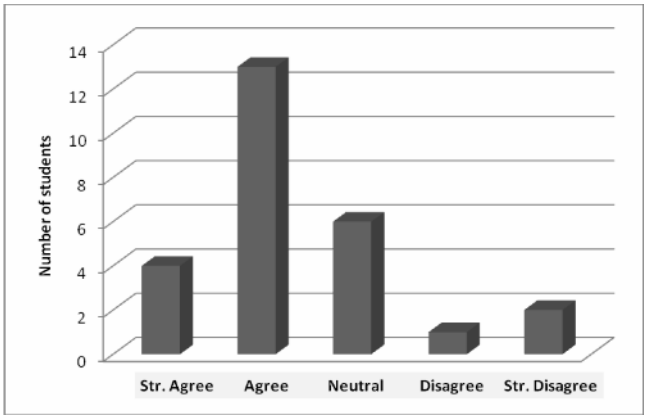

Fig. 9 applying patents for an innovative idea

Question #9. The project gave me idea about how to write a patent in case I have to. 61% of the respondents agreed. Distribution is shown in Fig. 10.

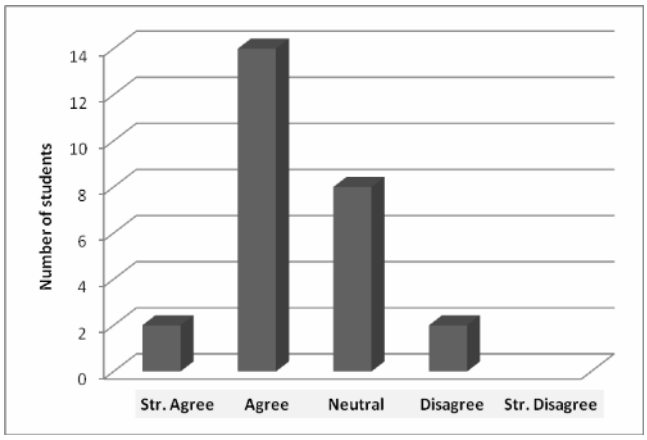

Fig. 10 apply for patent in case needed

Question #10. After studying patents, I find patenting procedure easier than I taught. 73% of the respondents have agreed. Distribution is shown in Fig. 11.

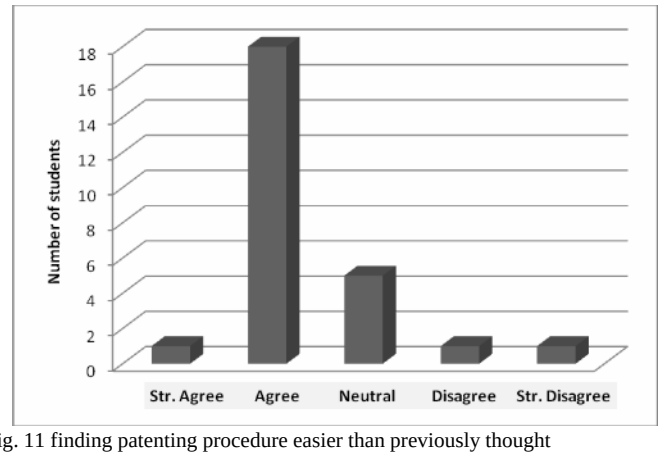

Fig. 11 finding patenting procedure easier than previously thought

Question #11. Overall, I find the project useful for the course. 84% of the students have agreed. Distribution is shown in Fig. 12.

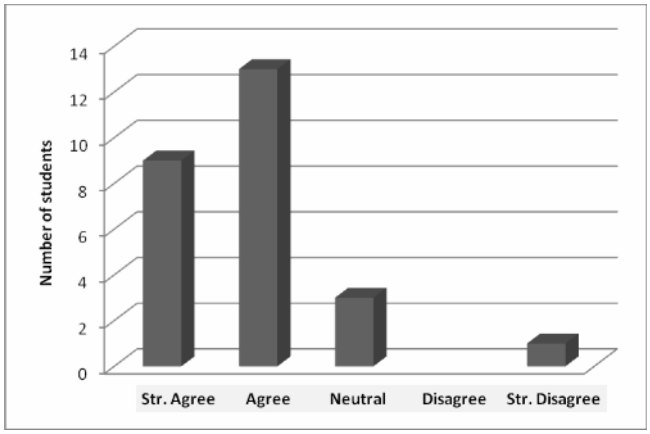

Fig. 12 usefulness of the project for the course

Question #12. Overall I enjoyed the project, it added to my knowledge of innovation. 73% of the students have agreed. Distribution is shown in Fig. 13.

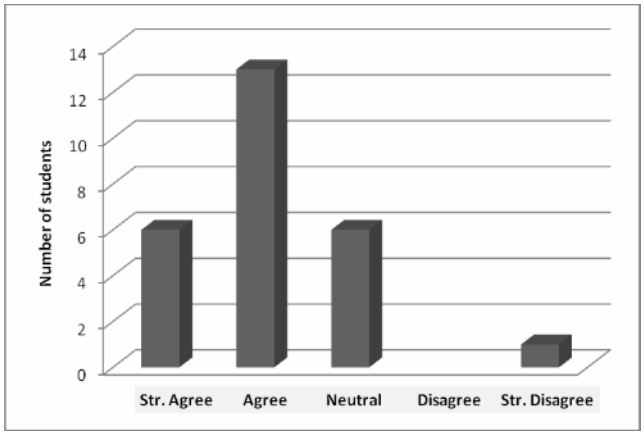

Fig. 13 contribution to knowledge of innovation

On a second survey conducted right after the grades were assigned, students were asked if the patent based project improved their understanding of soft computing concepts. Some of the questions overlapped with the first survey. This time the answer scale is altered for each question to make sure that students comprehended the questions. Questions and average value of answers are presented below.

1) Did studying the patents made you understand the fuzzy logic concepts better? 80% of respondents agreed.

2) Did studying the patents kindled your interest in engaging innovative work like designing new things? 86% of students agreed.

3) After studying the patents, have you felt that some of your ideas you had in other courses or times may be patent worthy? 86% of students agreed.

4) Would you prefer to have a regular common project assigned by instructor for COE 482, over patent based individual project? 71% of students favored patent based project.

5) How do you rate the contribution of patent project to your knowledge in terms of fuzzy logic, patenting etc. 57 % of the respondents found it as a valuable experience.

VII. Analyses of Survey results

In order to evaluate if the objectives of the experiment is met, end of semester course survey and special survey results are evaluated. The questions and answers relevant to objectives of the experiment are listed and analyzed below.

A. Objective 1: Increasing Motivation Toward the Topic of the Course.

To measure the response to this objective, students were asked several 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 students agreed. Response is given in Fig. 14.

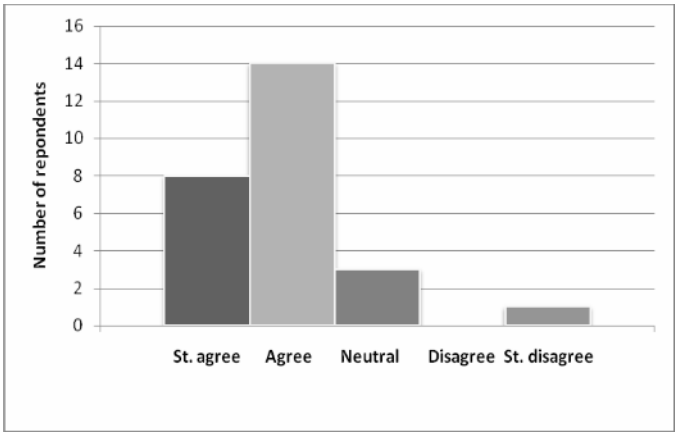

Fig. 14 effect of project on understanding the topic

• Question: Instructor's teaching method made it easy to follow lecture and helped my understanding. Response is given in Fig. 15. 78% of students agreed.

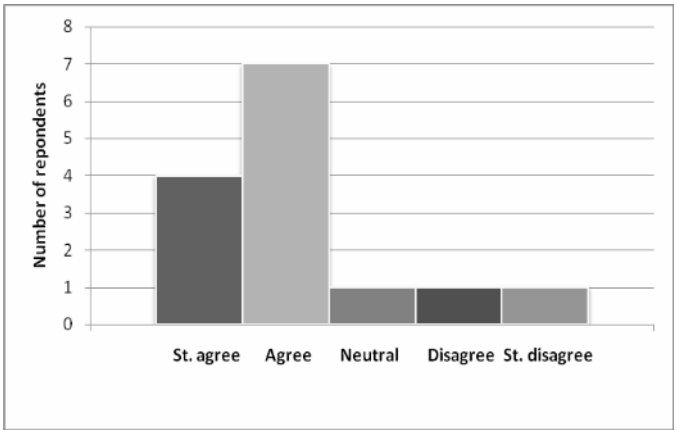

Fig. 15 evaluation of teaching method

B. Objective 2: Enhancement of Constructivist Teaching Approach Through Realistic Case Studies.

Several questions asked during the surveys were related to this objective. The questions and answers are listed below.

• Question: The project showed me that soft computing techniques can be applied to everyday procedures to get patents. 89% of respondents agreed. Distribution is shown in Fig. 16.

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

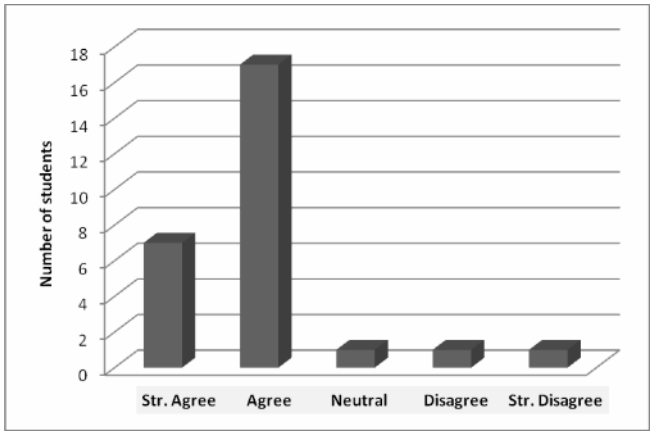

Fig. 16 contribution of patent study to constructivist learning approach

C. Objective 3: Use of Good Undergraduate Course Design Principles

One of the objectives of the experiment was to make course better by applying appropriate principles mentioned in section IV. Two of the survey questions were related to this objective. These questions and answers are listed below.

• Question: I find the patent related project interesting. 92% of the respondents agreed. Distribution is shown in Fig. 17.

• Question: Overall, I find the project useful for the course. 85% agreed.

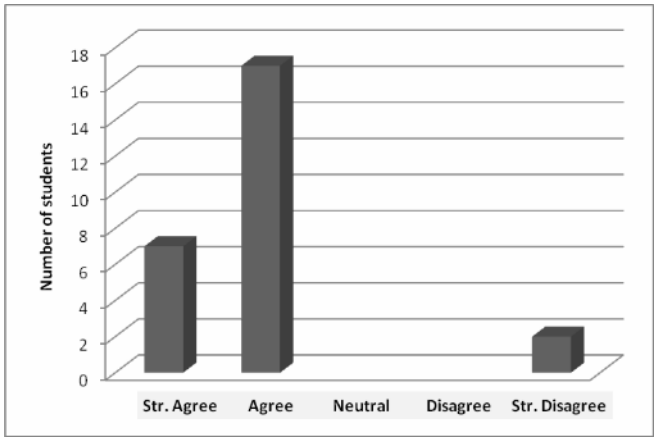

Fig. 17 effective use of good undergraduate course design principles

D. Objective 4: Increase Awareness of Students Toward Innovation

Students were asked to respond to following questions which were somehow relevant to this question:

• Question: The project has given me idea how to innovate new products. 77% of respondents agreed. Distribution is shown in Fig. 18 below.

• Question: The project has kindled my interest in applying for patents in case I come up with an innovative idea. 65% agreed.

• Question: The project gave me idea about how to write a patent in case I have to. 61% agreed.

• Question: After studying patents, I find patenting products easier than I taught. 73% agreed.

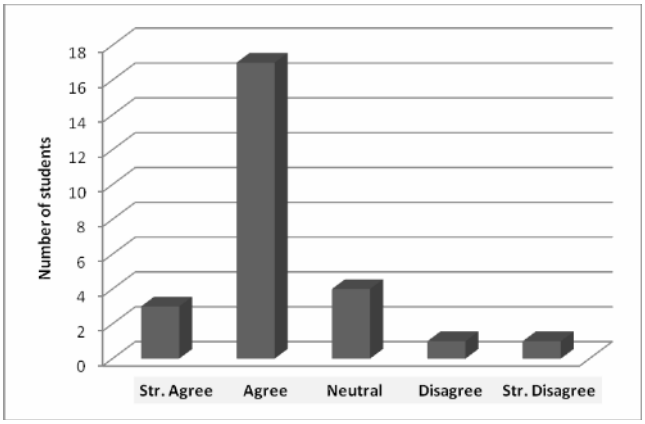

Fig. 18 contribution of project to innovative spirit of students

VIII. Conclusion

Senior students of computer engineering department who were registered for the Soft computing class were neither exposed to patents before nor had any expectation of learning about patents when they have registered for the course. To such uninitiated audience the idea of "using patents as a learning tool" has been introduced and their responses are measured using surveys.

The survey results indicated that majority of the students found the patent based project 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.

It is understood that a single course can not change the attitude of students toward innovation and give entrepreneurial spirit. It is also understood that survey results from a single course can not be generalized to give conclusive evidence about the benefits of patent studies. However, the results of the experiment were very encouraging and found beneficial by many students as well as the instructor of the course.

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

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