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Jump Starting Innovation in University Education*

Üniversite eğitim sisteminde inovasyonu canlandırma denemesi

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Özet

Yenilikçi buluş yeteneği de diyebileceğimiz inovasyon kabiliyeti çağımızın en kıymetli öğelerinden biri olup, ülkelerin ekonomik ve teknolojik gelişimlerini hızlandıracak en önemli etkenlerden birisidir. Üniversite - Devlet - Sanayi üçgeninin sağlıklı çalışmasıyla hayata geçebilecek olan inovasyon çarkının başlangıç noktası üniversiteler olup, bu kabiliyet ancak üniversitelerin gençlerimize yenilikçilik ve girişimcilik ruhunu aşılamasıyla mümkün olabilir. Her ne kadar bu gerçek iyi bilinse de, bu amacı pratikte geliştirebilmek kolay bir iş değildir. Üniversite lisans seviyesi öğrencilerinde inovasyon kabiliyetini artırmak için yaptığımız deneylerde derslerin içeriğine uygun patent dokümanları kullanarak öğrencileri motive etmeye çalıştık. Patent dokümanlarını kullanarak öğrencilerin *know-how* ve *know-why* bilgilerini artırmaya çabaladık. Yaptığımız deneylerden elde ettiğimiz sonuçlara göre doğru yöntemlerle ve araçlarla öğrencilerde inovasyon kabiliyetinin hızlı bir şekilde tesis edilebileceğini müşahade ettik. Makale bu konuda yaptığımız deneyler ile metodolojimizin detaylarını ve sonuçlarını açıklamaktadır.

Anahtar sözcükler: Eğitim teknolojisi, işbirlikçi eğitim, *know-how* eğitimi, *know-why* eğitimi, mühendislik eğitimi, özbelirleme kuramı, patent eğitimi, teknolojik inovasyon, yorumlayıcı eğitim.

Abstract

Innovation capability is considered the most valuable asset in the modern world. Within the innovation circle of University – Industry – Government policies, the universities are expected to lead the way in innovative thinking and innovation by educating and graduating students who have this capability. Although, this fact is very well known, how to achieve this in real life, under practical circumstances has been an elusive goal. In a long-term experiment conducted with students, different ways of increasing motivation and innovation capability of undergraduate students has been experimented. Specially selected patent documents are used within the context of the course for teaching course contents. By increasing know-how and know-why of students, their motivation toward the course is increased. The experiments have indicated that using right tools and methodology, it is possible to jump start innovation among uninitiated students at both undergraduate and graduate level. The paper discusses the philosophy behind the methods used and the type of courses suitable for jump starting innovation as well as criteria for selecting study documents.

Anahtar sözcükler: Collaborative learning, constructionist education, educational technology, engineering education, know-why, patent education, self-determination theory, technological innovation.

Innovation is regarded as one of the most valuable assets in the current century which according to some even surpassed the value of natural resources like oil, coal or diamond. Being so desirable, there is considerable desire on every country to facilitate establishment of innovation circle. Those countries that have the innovation infrastructure already established desire to maintain and expand it and those who do not possess the infrastructure search for ways of implementing it.

The studies have indicated that innovation circle is made up of government policies, industry and academia. It is possible to activate this cycle and keep it rolling only by adapting coherent policies by all members of the innovation circle. This paper will be focusing on the academia part of the innovation circle which is regarded by many researchers as the starter of the innovation engine.

Internet and easy access to communication technologies have changed the type of demands from students of the new

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era. The academia needs to adapt to these changes and educate students accordingly. The type of students/graduates needed to activate the innovation circle and keep it rolling are different than yesterdays engineers. This new type of engineers are labelled as "entrepreneurial/enterprise engineers by Tryggvasson (Tryggvason & Apelian, 2006).

According to Tryggvasson, "the engineers of the new era" are expected to have the following traits;

- 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."

The above description of the engineers of the "new era" indeed seems very ambitious, but the requirements of the "new era" dictate this description. Easy access to information has forced the engineers to assume this new role with the above job definition as described. Fulfilling these requirements is not easy and requires students of the "new era" to be motivated strongly toward achieving this 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 very well, with quality 'conceptual learning' rather than 'shallow learning'. Conceptual learning means learning with a deep understanding of the subject whereas shallow learning means learning just enough to pass the course with no regard to contents of the course.

In many educational institutions the problem is not the ability to access the quality educational material, but how to motivate students to participate in quality conceptual learning. Through internet today's students have access to unlimited educational resources, and lectures from the best institutions of the world. Yet, when we look at our classrooms, we see students who are not very enthusiastic about what they are learning. As Luechtefeld and Watkins indicated, too many engineering students are passive and dependent learners, whose main interest seem to be "Will this be on the test?" (Luechtefeld & Watkins, 2009). According to Luechtefeld and Watkins, the underlying root problem of this type of behaviour is the type of motivation used to push forward the student learning which emanates from the traditional 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. Although the Luechtefeld and Watkins commented specifically on engineering students, the observation can easily be extended to other colleges and specialisations.

The problem of motivation is more profound in educational institutions located in countries where there is lack of industrial base. In such places, local companies often utilize engineers for service related operations; design related applications are rare. Most applications are mundane applications which require no innovation from the individual whatsoever. 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 students who graduate with such attitude toward design courses remain crippled for the rest of their career.

Importance of Teaching "Know-Why" to Students

Innovation cycle of a country can only be activated by individuals who have innovative spirit. Although our goal is to kindle innovative spirit in our students during their education, this goal cannot be achieved without having some pre-requisites. The pre-requisites for having innovation capability within individuals are:

- strong technical background knowledge,
- strong self-confidence,
- strong motivation.

Without these essentials, the innovation capability cannot be developed.

The ultimate aim of education is to give the students the ability to do something. The courses of the educational curriculum are designed to educate students about a specific goal and give ability to achieve it. In order to give this ability to a student, two distinct issues should be tackled together; one is teaching how to do something and the other is teaching why it should be done (Schuitema, 2004). Although both "how" and "why" are important to the learning process, knowing

"why" seems to be more important than knowing "how" in priority. Learning "why" we do something usually tickles the curiosity of the students who will start searching for ways of solving the problem. In other words, learning "why we need to do something" leads the way to searching "how we can solve the problem". So, learning "why we need to do something" motivates the student to learn ways of solving the problem. Motivation seems to be the key to quality learning and innovation.

Patents as a Tool for Motivation

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 regular coursework. We have found the results of the experiment pleasantly surprising. Literature search indicated that importance of patents in education have been emphasized by other researchers as well. McCorquotodale, in his article stated 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 (McCorquodale & Brown, 2004). He concludes that wealth of information can be gathered from studying patents. Another researcher Garris, considers patent system as an essential tool for education of engineers (Garris, 2001). According to his conclusions, patents can be a very useful tool in engineering education and patent databases should be used as a teaching tool more frequently in engineering education. According to Garris, patenting system is initially designed for the purpose of advancement of science and technology, yet nowadays this fact is almost forgotten by many. Another researcher, Baldwin, 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" (Baldwin, 2007).

The constitution of United States of America, Article 1, Section 8.8 declares that the patent system is established "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".

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 notion 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.

An Experiment in Incorporating Patents into a Design Course

In this section the details of the experiments conducted over time are discussed. The experiment is conducted with one course in year 2007 and with two courses in year 2010.

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 number of stations in the lab as well as hands-on nature of the course. 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 two members and each team is assigned an individual project.

The course is selected as a testing venue for implementation of constructivist approach to see if it is possible to seed spirit of innovation to students. The experiment was conducted in two stages. During the initial offering of the course in 2007 patents were introduced as a novelty into the course without much expectation from the instructor. However the results from the experiment have been surprising and very encouraging. Based on the results of the first experiment, the educational experiment with patents is done once again in 2010. This time the experiment have been redesigned carefully by putting emphasis on the patent issue from the beginning of the course. The details of the two experiments are listed in the following sections.

Initial 2007 Experiment with Patent Based Education

Initial experiment was conducted in Spring 2007 semester offering of the course by modifying the project part of the course to include patent based projects. In this particular offering, the instructor has decided to use fuzzy logic related patents as a source for projects. The results of this experiment have been published by author (Ozkul, 2008). In this experiment students did not know about the intention of the instructor regarding patent related projects in the beginning of the semester and had no expectations related to learning about patents. Students were informed about the patent based project in the middle of the semester right before the projects were assigned. Group of fuzzy logic related patents which are interdisciplinary in nature are selected by the instructor distributed to student groups. Groups were given choice to select the topic of their interest among a pool of patents selected by the instructor of the course. All of the patents selected were collected from a pool of recently issued patents with publication date of 2007 (the year of offering). Students were asked to study their patents, and implement the idea using the Computer Aided Engineering (CAE tools) that they have, and present their working model at the end of the semester along with detailed explanation of the problem. Computer Aided Engineering (CAE) tool is a software program used in the course for implementing fuzzy logic systems. The tool enables students to enter verbal rules and generates a system which functions as desired.

Objectives of the 2007 experiment

The objectives of the experiment were as follows:

- Use the project part to increase the motivation of the students toward the course,
- Change the teaching model of the course to embody constructivist principles,
- Use "good undergraduate design course principles" to turn the course into a better engineering design course.
- Use the course to increase awareness of students toward innovation in engineering.

Administration of the 2007 experiment

Major parameter used for the fulfilment 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 fulfilment 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 how a patent document is organized. During the introduction particular emphasis placed on objectives of "Background", "Description" and "Claims" sections of patent documents. Each one of these sections provides valuable information toward fulfilment of the objective of the experiment.

"Background" section of patent introduces the problem that is being targeted 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 invention. 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 the patents found to be important since it contains information about how to protect the novel idea from possible infringements. Studying "Claims" part is also important to understand the legal implications of not choosing appropriate words in writing patent applications.

Students were asked to form their own 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 paid to select patents with very recent dates of publication. In this particular case, all patents were selected to be using fuzzy logic based patents for solving engineering problems which are published in year 2007 (the year of experiment). The decision of selecting up-to-date patents turned out to be very critical for this experiment. Initially this fact was not foreseen by the instructor, but at the end this appeared as a crucially important detail which helped to increase the motivation of students.

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

The survey results of 2007 experiment

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 were assigned.

The objectives of the experiment were as follows:

- **Objective 1:** Increasing motivation toward the topic of the course.
- **Objective 2:** Constructivist approach through realistic case studies
- **Objective 3:** Use of good undergraduate course design principles
- **Objective 4:** Increase awareness of students toward innovation

Degree of success of objectives are measured by using series of questions asked to students at the end of the semester. Respondents answered questions by giving answers in typical five-level Likert scale which consists of following categories; 1. Strongly agree, 2. Agree, 3. Neutral, 4. Disagree, 5.Strongly disagree.

Survey results, related to objectives of the experiment are given in Table 1.

Objective 1 is about increasing the motivation of the students toward the course by utilising patents as case study tools. This objective was measured by using Questions 1 and 2 where the average of 81.5% of the students has agreed that this objective is achieved.

Objective 2 is about applying constructivist principles of teaching using realistic case studies. The success of Objective 2 is measured by using Questions 3 and 4 where 84% of the students have agreed that objective was achieved.

Objective 3 is about using good undergraduate course design principles and it was measured by using Questions 5 and 6. Average of 88.5% of the students has indicated that this objective was achieved successfully.

Objective 4 is about increasing awareness of students toward innovation and the success of this objective was measured by using Questions 7, 8, 9 and 10. The students have indicated that 69% agreed that this objective was achieved.

According to these results, the students have found patent based project interesting and beneficial for the course. The results about the innovation part of the survey were surprising. Although the primary intention of the experiment has nothing to do with increasing innovation, the survey answers and the informal communication with the students indicated

Table 1. Survey results of 2007 experiment

Questions	Percentage agreed (Strongly agree +Agree)
Question 1: Studying patents increased my understanding of fuzzy logic and soft computing.	85%
Question 2: Instructor's teaching method made it easy to follow lecture and helped my understanding.	78%
Question 3: The project showed me that soft computing techniques can be applied to everyday procedures to get patents.	88%
Question 4: Did studying the patents made you understand the fuzzy logic concepts better?	80%
Question 5: I find the patent related project interesting.	92%
Question 6: Overall, I find the project useful for the course.	85%
Question 7: The project has given me idea how to innovate new products.	77%
Question 8: The project has kindled my interest in applying for patents in case I come up with an innovative idea.	65%
Question 9: The project gave me idea about how to write a patent in case I have to.	61%
Question 10: After studying patents, I find patenting products easier than I taught.	73%

that the patent based project was instrumental in kindling innovative spirit of the students.

Year 2010 Experiment with Patent Based Education

Pleasantly surprised and encouraged by the results of the 2007 experiment, the instructor has decided to experiment with the course once again in year 2010, this time putting more emphasis on patent and reorganizing the course around patent based education. In this offering increasing innovation capability was set as one of the primary objectives of the experiment. The course was offered once again in Fall 2010 semester. In the earlier 2007 experiment the students had no prior knowledge of involvement with patents during the course and resultantly no expectations. In Fall 2010 offering of the course, the students were informed in advance that the course would involve learning and using patents during the semester. Students did not have any prior knowledge about intellectual property other than preliminary information presented in some freshman level undergraduate courses.

Total of 22 students were registered for the course, where most of them were senior and few of them junior students. The objectives and administration methodology of the course has changed to accommodate the new objectives. In the new offering the objectives are set to be more ambitious and were as follows;

Objectives of the 2010 experiment

The objectives of the 2010 experiment were as follows:

- **Objective 1.** Increase the motivation of the students toward the course by using up-to-date patents,
- **Objective 2.** Change the teaching model of the course to embody constructivist principles,
- **Objective 3.** Use the course to kindle the innovative spirit among students toward innovation in engineering.
- **Objective 4.** Educate students about intellectual property and how to read and understand patent documents,
- **Objective 5.** Educate students about how to search patent databases,
- **Objective 6.** Educate students to a level that they can write their own patent documents.

Administration of the 2010 experiment

In this particular offering of the course, students were informed upfront that the course will involve reading and understanding patent documents related to the contents of the course. Course outline has not changed and the usual course material is administered during the beginning of the semester. After the fuzzy logic part of the course has been given, two lectures were devoted to intellectual property with special emphasis on patent documents. Fuzzy logic related application examples were explained by using patents which were published recently in year 2010. Patent documents are selected from those that are related to high technology applications and assigned to well known multinational corporations. Patent documents are distributed to students and important parts of the patent documents; such as background, summary, description and claims parts were explained by the instructor in detail. This is done in addition to what is usually administered during the course.

During the neural network part of the course, a similar strategy has been followed; neural network principles were explained, examples were done using computer aided engineering tools and when it was time to teach application examples, up-to-date patents were used to explain the high-tech applications.

Project assignment phase of the course has received considerable attention from the instructor. During the project assignment students were asked to form groups of two and they were asked to fill a survey form which indicated their background, interest and hobbies. Depending on their background and interest, the student groups were directed toward areas of new developments where technology was advancing. They were coached, within their interest area, to think out-of-the-box and identify needs. Once project topics where established, students were asked to do preliminary design of their projects. During this phase, students were also taught how to search patent databases. They were educated about patent categories and how to search patent databases properly. Students were asked to find patents which are related to their project; and each team coached by the instructor individually to indicate infringements and dissimilarities with the existing patents. Some of the groups have found patents which were very much related to their project idea. In such cases the groups were coached to look into details of the patent to understand the claims and see if the method developed by the students were different or not.

This stage has been very motivational for many of the students. The groups who did not find any patents related to their project idea were encouraged to go forward with their idea. Even those who have found patents related to their project idea were motivated in a different way. One of the groups has found a patent document which was exactly similar to their idea from a major automotive corporation which was published only one month earlier. It was surprising to see that the group was motivated by this finding rather than being discouraged. They were happy that their own idea was in the same ballpark with a major corporation which had a strong track record in innovation.

Titles of projects of 2010 experiment

The titles of projects developed by students are as follows;

- Fuzzy logic based, environmentally friendly, low drag coefficient, smart side view mirrors with dead spot vehicle detection sensor
- Fuzzy logic-based co-pilot to warn the driver about the road condition and safety level of the driving.
- Fuzzy logic based stunt driving trainer system
- Fuzzy logic based drunk driver behaviour detection unit for vehicles
- Fuzzy logic based, Multiplan, SMS paid parking system
- Intelligent turn signal cancellation system
- Fuzzy logic based road rage behaviour detection unit for vehicles
- Neural network-based custom tailoring and production system
- Fuzzy logic based parking lot guidance and payment system to assist customers
- Fuzzy logic based eyeglass frames a suggestion system based on customers facial features
- Fuzzy logic based front spoiler height adjustment system

Students were asked to write patent documents with abstract, background, summary and description for their projects. Groups also presented their projects and explain their work to their classmates.

The survey results of 2010 experiment

Instructor has conducted the survey similar to the survey conducted in the 2007 experiment to measure the interest level of students. To measure the response to this objective, students were asked questions that may relate partially to this objective by using the five-level Likert scale of, 1. Strongly agree, 2. Agree, 3. Neutral, 4. Disagree, 5. Strongly disagree. Survey results are given in Table 2.

According to the results of the survey, majority of the students have indicated that objectives of the experiment were mostly achieved. Answer to Question 4 has received only 50% agreement which indicated that the course was not perceived as "soft computing" course anymore and was perceived by a high percentage of students as a "patent writing" course. As a "patent writing" course it seems to be successful since in Question 9 90% of the students indicated that they can write a patent application if the needed to. Answer to Question 6 received only 59% agreement which indicated that learning patents is not as easy as it seems.

Suggestions Regarding Applicability of the Method for Other Courses

The experiment conducted was for a specific course and obviously it cannot be claimed that it would work for every subject. However, based on our experience we can make the following recommendations regarding applicability of the method to other courses.

- In our opinion, teaching through patent approach is best suited for mature audience, like junior/senior students.
- 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

Table 2. Survey results of 2010

Questions	Percentage agreed (Strongly agree +Agree)
Question 1: I find the patent related project interesting.	77%
Question 2: I think the project was relevant to the course.	77%
Question 3: The project showed me that the soft computing to techniques can be applied to everyday procedures to get new patents.	81%
Question 4: Studying patents has increased my understanding of fuzzy logic and soft computing.	50%
Question 5: The project has helped me to understand it patent language and that patent procedure.	77%
Question 6: Learning about patents, how it is written was interesting.	59%
Question 7: The project has given me idea how to innovate new products.	77%
Question 8: The project has kindled my interest in applying for patents in case I come up with an innovative idea.	77%
Question 9: The project gave me idea about how to write a patent in case I have to.	90%
Question 10: After studying patents, I find patenting products easier than I taught.	63%
Question 11: Overall I find the project useful for the course.	77%
Question 12: Overall I enjoyed the project, it added to my knowledge of innovation.	77%

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.
- 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.

Conclusions

A two stage experiment was conducted with senior level students for determining effectiveness of using patents for teaching purposes and its effect on kindling the spirit of innovation among the students. The students were neither exposed to patents before nor had any expectation of learning about patents when they have registered for the course. We have introduced the idea of "using patents as a learning tool" to such an uninitiated audience and observed their responses by measuring their reactions through surveys.

The survey results of the initial offering 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 the course 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. Although it was not the primary intention, we have observed strong motivation and kindling of innovative spirit among students due to getting familiar with patents and patenting process.

Pleasantly surprised and encouraged by the result of the first experiment, the approach to the course is redesigned and course is offered once again with the primary intention being increasing the innovation capability of students. The result of the second experiment has surpassed the expectations of the instructor and resulted in 11 patent-worthy projects from a group of 22 students.

The experiment has been very significant and indicated that even uninitiated students, who have no prior knowledge of patent or patent procedure nor desire to invent anything, can be taught and coached into designing innovative products which are novel and patent-worthy. During the course of the experiment students were disappointed time to time by finding out what they have contemplated were already patented. Yet, even this type of experience has been found very motivational by the students. It is very rare to find that result of an experiment can be motivational regardless whether the result is positive or negative. The student groups who have found their ideas already patented by others were also motivated by the result, discovering that they can invent cutting-edge technology products and can compete in the same league with world class corporations. Overall, the utilization of patents in high level undergraduate courses has been found very motivational and educational.

The experiment was later conducted in limited scale with graduate courses. The method has been found to be even more effective with mature student groups like graduate students.

In conclusion, the author's experiment with using patents in teaching courses has been very encouraging both for undergraduate and graduate level courses.

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