Pursuing the Elusive Goal of Responsible Research and Innovation: Using Patent Enhanced Education in Higher Education

Tarik Ozkul

Computer Science and Engineering Department
American University of Sharjah
Sharjah, UAE

Abstract

Instituting "responsible research and innovation" among university students is a highly desired yet elusive goal. In this paper, we explain the goals of "responsible research and innovation" and present a method which we found to be effective in achieving this purpose. We have started utilizing this methodology in 2007 and since then the method has been altered and re-examined several times over in different shapes with changing audiences. After experimenting with it for more than 7+ years, we have derived conclusions about how the method should be executed and for which audience it would be best suitable.

1. Introduction

We have started experimenting with "patent enhanced education" in engineering courses of American University of Sharjah in 2007. What began as a curiosity experiment has worked out to be an interesting tool for increasing responsible research and innovation drive among students. Initially, patents and patent education introduced to the course for the purpose of adding realistic, real-world case studies. Although the initial experimentation was not destined to accomplish anything other than adding real life applications to the course, the response and enthusiasm demonstrated by the students had encouraged us to explore the subject farther. It was particularly interesting to see students' unsolicited declaration of "increased entrepreneurial spirit" which made us proceed with the experiment further. Increasing entrepreneurial spirit of students' was never an intention of the experiment, but it became an unexpected but much welcomed byproduct.

After the initial 2007 trial, "patent enhanced education" experiment has been repeated several times in different courses with different maturity level students. The methodology was refined and fine-tuned with each experiment. Unlike the first trial where the experiment was carried without a clear

goal, the repeated experiments were carefully crafted toward achieving specific ends. The methodology has been used in different courses with different maturity level audiences. This paper summarizes our 7+ years of experience with this methodology, how it increases responsible research and innovation and how it should be applied for best results.

2. What is "Responsible Research and Innovation"

Modern society faces many challenges. One of the biggest challenges of toady is the resuscitation of the environment which has been stressed severely due to neglect and irresponsible actions of past generations. In order to slow down the destruction cycle and repair the damage, we need to have all societal actors to be involved in construction of innovative solutions, services and products that does not harm society or the environment. The set of actions desired to initiate this change is reflected in a contemporary term called "Responsible Research and Innovation". The term "Responsible Research and Innovation" is defined by von Schomberg as follows [1]:

"A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society)."

The above definition of responsible research and innovation is embraced by the European Commission as guidelines for conducting EU wide research activities [2]. Reaching the goal of implementing "Responsible Research and Innovation" among societal actors is not an easy job and takes conscious and well-planned long term endeavor. In many instances "Responsible Research and Innovation" is associated with "sustainable"

innovation and researchers tried to figure out the factors that promoted "sustainable" product design among companies. One of such research is done by Geenhuizen and Ye where the duo suggests that "open knowledge networks" may contribute to formation of Responsible Research and Innovation among young companies [3].

In many instances it is contended that "students" and their education is the most significant element in generating "responsible generation". Many researchers proposed ways of improving science and engineering education so that coming new generation of engineers would know how to solve the problems that we passed on to them. Galloway [4] proposes reforming education seriously to generate engineers with following qualities:

- Ability to serve on multidisciplinary teams;
- People with an understanding of professional and ethical duty;
- Ability to communicate effectively;
- Equipped with the broad education necessary to understand the impact of engineering solutions in a global and societal context;
- Identification of the need for, and an ability to engage in, lifelong learning;
- Have knowledge of contemporary issues;
- An understanding of commercial enterprise and public policy and administration fundamentals;
- An understanding of the role of a leader and of leadership principles and positions.

Galloway's argument can be interpreted as a request for emphasis on education to get people with responsible research and invention skills.

2.1. Key factors of "Responsible Research and Innovation"

According to EU interpretation, Responsible Research and Innovation has five key components [2]:

- Societal engagement of all actors: researchers, industry, policy makers and civil society in the research and innovation process
- Gender equality: engagement of both men and women in research and innovation content,
- Science education: increase number of researchers and boost interest of young in science and technology,
- Open access: giving free access to results of publicly funded research,
- Ethics: ensure social relevance and acceptability of research and innovation outcomes

The underlying intention behind the framework of responsible research and innovation can be interpreted as quest for a new way of thinking, new way of design, new way of handling matters so that solutions, products are beneficial to society and the environment. Observing the environment and the ill effects of climate change that we experience every day in every part of the world, it is obvious that we reached the end of the rope. Unless immediate drastic action is taken, the environment that we live in soon will be unlivable.

Although the idea of RRI is novel and the intention behind is commendable, how to reach that goal is not clear. There is no clear course of action established by political authority to reach that elusive goal. Unless these key principles find way from our lips to our hearts and turn into action, we should not expect any real change in what is going on around us. So far the policy changes to implement RRI action is either non-existing, insufficient or downright contradictory what is supposed to be done.

Under the circumstances of existing policy confusion and apathy toward establishment of responsible research and innovation, the author wishes to present "patent enhanced education" as a possible practical way of implementing goals of responsible research and innovation in our young generation.

3. What is Patent enhanced education

In order to understand how patent enhanced education can be instrumental in instilling responsible research and innovation in university students, we need to understand what patent enhanced education is.

Patent enhanced education is a way of delivering course contents blended with patent information in such a way that the added patent information reinforces the course contents. The purpose of the "patent based course delivery" is not to teach reading or drafting patents, but to use the "patent" database and data in patent documents to reinforce the course contents. During the delivery of the course, students learn reading and writing patent documents, use relevant patent documents for case studies, prepare patent based projects. During this process, all patents related materials used are relevant to the course contents. Since the focus of the approach is on the course contents rather than "teaching patents", educating students about the mechanical aspects of patents is blended into course contents in a subtle way without stealing much attention from the course contents. Our experience indicated that when performed carefully, this manner of pedagogy can be applied not merely for teaching the regular course contents, but may also increase motivation,

innovation and entrepreneurial drive in students during the process.

3.1. Importance of Patents in Education

It turns out that importance patents in education have been emphasized by other researchers before. McCorquadale and Brown have emphasized the importance of intellectual property education and argued that "wealth of information" can be garnered from reading patents. They conclude that, the issue of intellectual property needs to be taught in universities just like whatever other course [5].

Another researcher Garris, has noted the importance of "patent system" and believes that it delivers an "essential purpose" in engineering design teaching. The patent system is designed to advance science and technology, yet this fact is, almost forgotten or overlooked by many. Garris argues in favor of using patents in education saying: "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" [6]. This is precisely the approach assumed in our experiments.

There are also other researchers who consider patent data essential in education and even find it downright dangerous not to incorporate patient education into higher education. Baldwin warns about this and mentions: "It is dangerous for modern design engineers not to be conversant with the function of patents in a competitive industry" [7].

3.1.1. Perception of Students about Patent Education. It is surprising to see an increasing understanding of the importance of patents among students. Although most universities and administrators enforce and emphasize the copyright and plagiarism side of IP matters, most of the time patent side of IP is neglected. Surprisingly, students found to be not only aware, but also demanding for "education in patent related matters". A recent 2012 dated landmark survey titled "Student Attitudes to IP and its teaching" clearly shows a changed student attitude toward this subject [8]. This study is conducted among 2000 higher education students of UK and organized jointly by:

- Intellectual Property Awareness Network, (NGO)
- National Union of Students, (NGO)
- UK Intellectual Property Office. (GO)

The survey results clearly indicate that today's students demand a different approach to intellectual property education. According to the survey, universities have to make radical changes to the way they teach intellectual property. Biggest complaint by students was the fact that currently universities emphasize mostly on "plagiarism" aspect of the copyrights but not enough on patent side of the

intellectual property to prepare them for the real world.

The following determinations of the study are quoted straight from the executive summary of the report [9].

- *"Overwhelmingly, students felt that knowledge of IP is important to both their instruction and their future career. There is evidence that IP teaching earlier in their education motivates greater interest among students at FE/HE level. Furthermore, once they are exposed to some aspects of IP, students feel more confident about it, and express a desire to know more."*
- *"Students feel it was important to know about IP to ensure everyone receives recognition for their work and ideas, but they do not perceive a strong link between IP and commercial success."*
- *"Academics, and module tutors in particular, are seen as key sources of information about IP issues. However, just half the students surveyed felt their lecturers to be well-informed about IP issues."*
- *"Many students want to see improvements to IP teaching. In particular, they want the teaching of IP issues to be more closely-related to their course discipline. They also called for coverage of IP to extend beyond plagiarism. Overall, only 40% of students consider their current awareness of IP to be enough to support them in their future career."*

Rachel Wenstone, Vice President Higher Education, National Union of Students states that; "*This pioneering research shows that students believe a knowledge of IP is important and those who have some experience of IP education view it positively and express a desire for more. However, the extent of IP teaching is currently very limited and many students are not even aware of the potential scope of IP education. Even where it does take place, IP education is frequently restricted to plagiarism, is not included in assessment, and makes little use of external experts.*" [9].

UK IPO office Acting Chief Executive Sean Dennehey states that "*An awareness and understanding of IP developed in education is key to achieving an IP savvy workforce which can use IP to deliver growth for the UK. What this report shows is that despite student appetite for IP knowledge and their desire for career relevant IP teaching to be integrated into the curriculum, few university courses address IP issues. Too often, our graduates leave university with little understanding of how to protect their ideas or maximize their value. Improving the provision of IP education within our universities will require support and action from a wide range of stakeholders from academia, industry and government. This report will help to focus*

attention on the challenge and the benefits that will flow from addressing it. The IPO is committed to working in partnership with all parties to shape curriculum development to ensure that IP teaching is included in a wider range of courses, in more locations across the UK to underpin the economic boost that will flow from maximizing the value of UK creativity" [9].

Based on the report David Willets, Minister for Universities and Sciences of UK calls for changes in accreditation system to address the needs saying: *"It is vital that we have an IP literate workforce to meet the challenges of a rapidly changing workplace. I believe the key to success is to garner support from professional bodies responsible for accrediting courses, as well as university and industry and to use that support to bring about changes to the curriculum."* [9].

Finally, Professor Ruth Soetendorp who leads Intellectual Property Awareness Network, (IPAN) Education Group says: *"This research confirms what we have long suspected: that students want to see IP teaching integrated in their courses. The UK's FE and HE course providers must now step-up to meet this need."*[10].

4. Patent enhanced education Experience at AUS

We have experimented with the operation of blending patent education into regular course several times. The process which we call "patent enhanced education" has been experimented several times with different level students and with different courses. The following approach is the one that we found most useful.

1. Students are well informed ahead of time about the "patent based approach" that will be adapted in the course. This creates an excitement and expectation in the students and increases curiosity toward the course even before the course starts. As the UK survey mentioned earlier states, students do know about the value of patents and desire to know more about it. By advertising this feature ahead of time, we not only increase the motivation of the students, but also create an air of curiosity to attract students to the subject.

2. Patent related material, specifically about reading and writing patent documents should be administered in the beginning of the course in order not to steal limelight from course contents later during the semester. It should be noted that, the course is not intended to be a "patent drafting" but on a specific topic enriched with patent data. For this reason patent related information should be given in the early part of the course.

3. From the very start of the class, most of the case studies should be selected from patent documents as much as possible. It is understandable that not everything in the course will be patent related. Basic subjects, principles, core concepts should be delivered using classical approach. But as for the case studies, we found patent documents to be very effective in relating industrially applicable applications of the core subject.

4. Selected patents for case studies should be as recently granted as possible. (The same calendar year is recommended.) They should be ideally selected from patents of well-known companies. It should be remembered that one of the major intentions of the exercise is to increase motivation of the students about the subject that they are studying. Having a recently granted patent document from a well-known company is found to be extremely motivating to students. This also gives the students the feeling that they are at the cutting edge of technology.

5. Students should be encouraged to prepare patent applications for their course related projects. It is well known that anything that is not practiced will eventually be forgotten. Project assignments present perfect opportunity for the students to practice what they have learned. Students should be encouraged to search databases on their own to explore further. This exercise also enables students to see what is granted and what is rejected from patent applications. This also makes a positive impact on students by teaching them what is patentable and what is not.

The details of the earlier experiments conducted can be found in [11, 12, 13, 14].

4.1. Impact of "Patent Education" on Learning

In all our offerings that used "patent enhanced education" approach, we have always conducted surveys with students over the course offering to capture their attitude and feelings toward the approach. Generally the students' responses have always been overwhelmingly positive. Although we know that students' liked the approach, "why" they liked it and how it impacted the knowledge construction process was not obvious from the surveys. The following reflects the opinion of the author about how this approach affects the knowledge building process.

1. Patents are an excellent source of information about "know-why" of many engineering problems. Knowledge of how to

do things is known as "know-how". Along the same line of thinking, knowledge of why we do things is known as "know-why". Knowing why we do something increases the motivation of students to learn the topic. Unfortunately, most of the time in classical teaching setup "know-why" information is either lost completely or it is so old that information remains as a mere historic fact which bears no relevance to current issues. Patents are an excellent source for "know-why" information. Every patent document has to have a section mentioning "background" of the invention. As a part of the requirement to prove novelty, the inventor has to explain the current technology as well as the deficiency of the current technology to prove that the invention is useful in one or more ways. While doing this, the inventor has to explain the "know-why" of the patent application in clear and understandable terms. By picking patents that are relevant to the course topic, which are also recently granted, deficiency of contemporary solutions is declared, and "know-why" of the inventions are explained. Since the knowledge is current and cutting edge, students can relate to the problem and the solution. This approach not only teaches "know-why" of the problem, but also bridges the gap with the current technology and the course contents. This approach alone has proven to be very useful in all our course experiments.

The Author believes teaching "know-why" of a real-world problem related to course contents through a patent document is one of the most important reasons why students like this approach.

2. Patents establish the connection between the course contents and the current technology while injecting entrepreneurial spirit into the students. To achieve this effect, it is important to select patents which are not only relevant to the course contents but also granted recently to well-known companies. Students associate patents from well-known companies with "success" while recent grant date means "up-to-date", cutting-edge technology. Studying successful examples, relevant to today's technology motivates students. Studying patents gives self-confidence to students in an interesting way. Most of the time when students are presented with a new patent, their first reaction is awe and respect. After examining the details of the patent and the technology behind the invention, which takes several iterations, the awe and respect is replaced by "I can do

that" confidence. Obviously this reaction cannot be generalized to all students, but happens frequently enough to be listed as a mechanism that motivates students. Author believes this buildup of self-confidence is another one of the reasons that makes this approach popular among students.

4.2. Recommendation for utilizing "Patent enhanced education" approach on courses

The following is the set of recommendation based on our 7+ years of experiments with this approach for those who would like to try the methodology. Some of the recommendations are based on subjective observations of the author, so no formal proof is available.

1. The maturity of the students is important. In our experiments we have found that graduate students benefit most from the approach. They value the patent blended information and typically set about putting the new found information into use in their master projects or dissertations. Senior level undergraduate students also seems to appreciate the overture and the methodology can be employed with them effectively. Yet the writer does not recommend "patent enhanced education" approach with freshman and sophomore level students.

   It is recommended that you experiment this approach with mature audience as much as possible.

2. Not every course is suitable for "patent enhanced education" approach. Best courses are science, engineering or technical oriented courses where patent information is relevant and can be found. The Author recommends searching patent databases for patents relevant to course content to see the patent landscape for the particular subject. Patent databases list patent applications as well as granted patents. The author recommends selection of granted patents rather than patent applications. Patent applications should be used only if there is lack of granted ones. Patent applications lack the notion of "success" which is an important factor in the process.

   It is recommended that before the course starts instructor selects sufficient number of patents related to the course.

3. Typically courses that deal with contemporary issues are better candidates for "patent enhanced education". The approach can be used with other courses as well, but the results may not be as successful as the contemporary related types. Reviewing cutting-edge solutions to contemporary

problems has a positive effect on the learning process.

4. It is recommended that classical textbook should still be used with the course. Course contents should be supplemented with patent related information.

5. Choice of recently granted patents is an important tip to remember during administration of the course. It is recommended that the grant date of the patent selected should be the same calendar year or the previous year at worst. Even the patents used for teaching the basics of "patent reading or writing" should be recently dated patents.

6. Selection of the patent assignee is another important point to remember during administration of the course. Patent inventor and the patent assignee are typically different entities in most instances. It is recommended that the assignee of the patents is selected from well-known companies. As it was mentioned in the previous sections, students associate well-known companies with "success" and this is important for pedagogical reasons. Obviously, if patents from well-known companies are not available, whatever is available should be considered.

7. Students should be encouraged to explore the patent database on their own. It is recommended that a course project should be assigned at the end of the semester where the students are required to conduct a search in the patent database to complete their project.

5. Effect of patent enhanced education on inspiring responsible research and innovation

The principles of responsible research and innovation is listed as follows [2]:

1. Societal engagement of all actors: researchers, industry, policy makers and civil society in the research and innovation process

2. Gender equality: engagement of both men and women in research and innovation content,

3. Science education: increase number of researchers and boost interest of young in science and technology,

4. Open access: giving free access to the results of publicly funded research,

5. Ethics: ensure social relevance and acceptability of research and innovation outcomes

First key goal of "responsible research and innovation" is societal engagement of all actors involved in the process. Societal actors essentially are researchers, policy makers and industrialists. Policymakers establishes the rules, provide guidelines, researchers work on the subject and finds solutions and industrialists commercialize the research and make it accessible to the society. It is expected that engagement of these actors results in finding solutions to real-world problems. As a result of this engagement, the policymakers point in the direction of real, pressing problems of society and invite researchers to conduct research by providing funding and directions. Solutions provided by the researchers are later commercialized by the industrialists. The key term in this principle is "real world problems" and actors tackling the problem from different aspects. Patent enhanced education and using real-world patents in courses focuses attention of students toward real-world problems early on in their career. In a way, students are mentally prepared to tackle real-world problems and get ready to play an active role in finding solutions to societal problems.

The second key principle of the responsible research and innovation is engagement of both men and woman in research and innovation content. This principle invites female members of the society, which almost constitute 50% of the population, to be active in participating and finding solutions. Any solution which does not take into consideration viewpoint and approval of both genders is doomed for failure. This is why participation of both genders is considered as an important factor in responsible research and innovation.

Patent enriched education seems to help this key point by inviting both male and female students to be active participants in finding solutions. In our patent based courses we have witnessed that "patent enhanced education" appeals to both genders. Patent enhanced education is an "empowering" experience which increases the self-confidence of students and it is found to be appealing to all genders. This way, "patent enhanced education" is expected to enhance gender equality.

The third principle of responsible research and innovation is proliferation of science education among young generation. In our experiments we have found that students are attracted to patent enhanced education because of the "empowerment" and richer learning experience. Although this exercise is intended for higher education students, the principles most probably will be appealing even to the high school students. This way it is expected that patent enhanced education can make a positive impact on responsible research and innovation.

The fourth principle of responsible research and innovation is giving open access to information and results of research supported by public funds. The

underlying intention of this principle is to invite as many potential actors as possible to participate in generating solutions to societal problems. As the first principle points out, the societal problems are real world problems which are pointed out by the policy makers and funded by the government through public funds. It is to the benefit of society to invite as many players as possible to generate the solution to the problem. By opening access to the results of previously done research, it will be possible to contribute to science.

A similar philosophy applies to patents; patent documents are freely available with the intention of contribution to science. In reality, patent is an agreement between the inventor and the government in which government gives protection to the inventor for a limited amount of time in return for an open declaration of the invention contents. By opening the information to the public, the principle of the invention is explained to the public so that new inventions can be built upon the declared invention. This method of improving science and technology has been found to be very effective since the middle Ages. Since then, the patent documents are open to public and not even copyrighted. In line with the ideology of this key RRI principle, patent enhanced education taps into a vast resource of open patent databases to contribute to science and education.

The fifth and the last principle of responsible research and innovation is ethics. Ensuring social relevance and acceptability of research and innovation outcomes. The underlying ideology of this particular principle is to ensure the generation of solutions which are not only relevant to needs but also ethically acceptable by the society.

Patent enhanced education helps fulfillment of this principle by engaging students in real-world problems. Without any doubt real world problems have somehow social relevance. By training students on real-world problems and real-world solutions we encourage solutions which are realistic and socially acceptable.

The Table 1 below summarizes how patent enhanced education is instrumental in achieving key goals of responsible research and innovation.

Table 1. How "patent enhanced education" helps to achieve RRI key goals

Five RRI keys	How "patent enhanced education" helps to achieve these key goals
Societal engagement	Patent enhanced education is taught and incorporated into selected high level courses. Patent enhanced education is found to cause engagement of students in real-world problems by teaching "know-why" of technology. Realistic problem solving quality that comes with "patent enhanced education" makes industry partners more engaged with universities. This way, main actors will be more actively engaged in Research and Innovation.
Gender equality and Gender in research and Innovation content	Patent enhanced education was found to attract both **male** and female students in previous tests. Patent enhanced education is an "empowering" experience which increases self-confidence of students and it is found to be appealing to all gender. This way, "patent enhanced education" is expected to enhance gender equality.
Science education, increase number of researchers and boost interest of young in science	Patent enhanced education empowers both academicians' and students' alike. This methodology is found to attract students to science and science related studies. It is expected that attractive features of "patent enhanced education" eventually will attract more youngsters into science and education while making them more innovative and productive.
Open access	The patents and patent information is freely available to public which, in essence, in full accord with "open access" mentality of the RRI framework.
Ethics	Patent enhanced education teaches students and academicians to engage in "real-world" problems which are undoubtedly socially relevant issues. As our students and engineers get more involved in real-world problems, eventually their solutions will be more realistic and more acceptable". This process eventually is expected to bring about the acceptability of research and innovation outcomes.

6. Conclusions

Based on our 7+ years of experience with "patent enhanced education" approach, we have found patent based education made a significant impact on students from the viewpoint of Responsible Research and Innovation (RRI). The following list summarizes the effect of patent enhanced education approach and how its impact is achieved.

- **Increased engagement with real-word problems**

Patents are inventions designed to solve real-world problems. Studying patents made students' more engaged with real-world problems which are one of the key goals of RRI. In most engineering courses "case studies" are done at the end of the semester to reinforce the material learned and show real world applications of the knowledge received. Most of the case studies that come with the textbook naturally are outdated and far from being cutting edge. Patent enhanced approach provides students the perfect "case studies" by providing up-to-date engineering problems. Rather than working on fictitious problems, working with real problems and proven cutting edge solutions to these problems teaches students how to tackle new problems.

- **Learning know-why of why we do things**

"Know-why" can be summarized as the driving force behind inventions. It is necessary to know the deficient aspect of the current technology in order to invent something to overcome this deficiency. Learning "know-why" increases motivation of students to learn more about the subject that they are studying. Typically finding "know-why" information is as difficult as getting "know-how" information. Know-why information is dynamic and cannot be learned from textbooks. Know-why information is the basis of many inventions. One needs to know the subtle deficiencies' of the current technology to find the improvement area for a patentable solution. Know-why information is embedded into the background section of patent documents and needs to state the existing technical problems in a realistic way and then gives solution. Learning "know-why" is found to increase curiosity and interest of the students toward subjects they studied. Increased curiosity is the key to more engagement and motivation and may lead to responsible research and innovation.

- **Increased self-confidence among students**

Learning how to read and write patents has been found to increase self-confidence of students. Although patent documents use a heavy legal language, nevertheless it is something that can be learned with great reward. It has been observed many times that even though students find it intimidating to read these documents at first, after repeated attempts they are able to read and comprehend the contents. As one student expressed it eloquently; once that happens "a treasure chest of knowledge" becomes available to students. This is found to increase self-confidence of students immensely.

- **Increased innovation activity among students and encouragement of innovative thought process**

Innovation is considered one of the most valuable assets in 21st century. Unlike common belief, innovation cannot be taught like regular course in a classroom. Innovation comes after hard work of observation, analyses, design, trial and re-design. Patent enhanced course provide students with some of the key elements of the innovative thought process. Being able to read and understand patent documents and being equipped with tools necessary for preparing patent applications made students search existing patents, and made them aware of patenting rules. Knowing what is patent worthy, what can be patented and what cannot, do contribute to innovative though process directly or indirectly. This, in turn encouraged them to express their innovative capabilities through patent applications.

- **Increased entrepreneurship among students**

The innovation is highly valued in the 21st century since it ultimately may provide employment to members of the society. The idea behind responsible research and innovation is to come up with solutions that benefits the society. So one of the ultimate goals of the responsible research and innovation is to provide solutions and companies commercializing these solutions in order to make them accessible to the society. This can be achieved by encouraging our innovators to become entrepreneurs at later stage. Patent enhanced education seems to provide a path to this elusive goal. In our experiments we have selected patents from well-known companies. Seeing the famous name brands and possible large monetary returns encouraged students to set up their own businesses. Many of the students' who participated in our experiments indicated their desire to set up their business.

- **Societal engagement of students**

Helping people, helping needy is desired by every decent human being. We would like to up bring a new generation who would treat the fellow human beings and the environment kindly. This requires engagement with real world problems in a realistic way. Since most patent documents deal with real world problems and practical solutions to these problems, students start getting involved in realities of life and the society early on. In our experiments we have observed that students become more sensitive toward solving problems of society after receiving patent enhanced education. This issue is considered as one of the key goals of RRI.

- **Increased ethical behavior**

While receiving patent enhanced education, students receive information about rules of patentability and what can be patented and how it can be patented. During this process they learn about the restrictions imposed by patent agencies on "stifling patents" of others. They learn about the rules for restricting scope of patent applications in order to leave room for the others to continue innovation. They learn about not patenting things like "surgical procedures" in order not to restrict common benefit to humanity. All these activities serve as guidelines of ethical behavior to students. In line with this knowledge, we encourage students to respect other inventors' claims and write claims in a way not to stifle others' innovation. Considering that most of the financial crises we have faced recently were actually problems emanated from "lack of ethics", more and more emphasis needs to be placed on this issue and should be considered as one of the key goals of RRI. Patent enhanced education can be used for teaching "ethical innovation".

- **Engagement of female students**

It is found that innovation attracts both males and females. In our experiments we have observed that, being empowered by the tools of innovation, ladies shine in their own way. This way we hope to increase engagement of females which is considered as one of the key goals of responsible research and innovation (RRI),

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