CURTIN ROBOTICS CLUB: CONCEIVING, DESIGNING, IMPLEMENTING AND OPERATING ROBOTS FOR FUN!

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ABSTRACT

The role of universities is to transform students into confident graduates that can contribute to the profession and the society. Students gain knowledge and skills as they participate in challenging and engaging learning activities. These activities can take place as part of the syllabus in a course, or as part of extracurricular activities. Robotics is very popular hobby among engineering-inclined young people. Today it is possible to build simple yet interesting robots investing little money or technical resources. Furthermore, Robotics as a hobby offers opportunities to develop skills and abilities desired in all Engineering Graduates. This paper proposes the use of extracurricular activities to offer students opportunities to develop professional skills and boost their confidence. The history and operation of the Curtin Robotics Club are presented as a case study to support the use of extracurricular activities.

KEYWORDS

Engineering education, extracurricular activities, student experience, graduate capabilities, Standards: 1, 2, 4, 5, 8

INTRODUCTION

The role of Universities in society

It is universally agreed that people go to universities to get educated, however, what does it mean to obtain an education in general, and a university degree in particular? There are many definitions of Education, some of them are: *"A form of learning in which the knowledge, skills, and habits of a group of people are transferred from one generation to the next through teaching, training, or research"* (Wikipedia, 2014), *"The systematic instruction, teaching, or training in various academic and non-academic subjects given to or received by a child, typically at a school"* (Oxford, 2014)*, "Education can be thought of as the transmission of the values and accumulated knowledge of a society"* (Britannica, 2014). Most definitions of Education emphasise the transmission of information from one generation to the next. However, information on its own does not constitute education. An individual can be very knowledgeable and still show rude manners and little interest in those around him. Is not education then, something more than just the transmission of information? For the purpose of this paper education will be defined as the process of transforming individuals' behaviour through learning. What differentiates universities is not so much what their students learn, but how this learning modifies their behaviour. In this context, the role of universities is to transform students into confident graduates that can contribute to the profession and the society. Figure 1 shows an interpretation of the interaction between universities, students and society (industry).

Figure 1. The role of universities in society

Students enter university when they are very young. During their years at Uni those teenagers who enroll in first year must be transformed into professional practitioners of a particular discipline. After graduation graduates compete for jobs in industry. In the recruiting process graduates have to demonstrate they are the best candidate for the advertised position. Some succeed, some do not. To close the loop, industry communicates with universities through advisory panels and accreditation bodies. This cycle provides society with opportunities for progress and innovation.

Each of the players in figure 1 has particular expectations from each other. Universities expect students to be enthusiastic and committed to their learning; students expect universities to be understanding of their particular needs and accommodate accordingly. Industry expects new employees to "land running", i.e. to contribute to the company from day one, while graduates expect industry to pay good salaries and offer a good working environment. Sometimes expectations are not met and problems arise.

The role of students at university

Students need to be told from day one that attending university is about becoming a different person through learning. Some of that learning will be pleasant, and some they will find challenging. Students need to understand that they come to university not to be taught, but to be exposed to opportunities to learn. Academics are just facilitators of a process they need to commit to and engage with. Students are the active part in the teaching and learning process.

Anyone who has taught at a university in the past 20 years would attest that, in general, students are coming to university less and less prepared. Research by Jones (Jones, 2011) and Lowe (Lowe and Cook, 2003) confirm this observation. Of course there always are *the brilliant ones*, those students who go on their own, who are motivated, know how to learn and use every opportunity given to them to learn and become a better person. Correspondingly,

there will always be *the lost*, students who enrolled in a particular degree for the wrong reasons and their lives become a never-ending struggle to pass the course. Between these two extremes are *the bulk*, students who have the potential to become better individuals when exposed to appropriate learning experiences. It is in this last cohort where well-designed learning activities can have a big impact.

What is missing in the new generations of undergraduates? It cannot be information. We live, and students know it, in a world where information is readily available as long as there is a connection to the Internet. Students know there is no piece of information Google or Wikipedia cannot provide. If it is not there, it probably does not exist or is not important. What students lack are basic intellectual abilities like how to ask questions or how to put together different pieces of information to solve a problem. And not surprisingly it is precisely this sort of skills what industry is looking for in university graduates (Brodie and Brodie, 2009).

Professional skills, or graduate attributes, are becoming a key element to differentiate students and universities. Accreditation bodies like Engineers Australia are shifting the focus from content to what student engineers can do at the point of graduation (EAust, 2014). In industry, recruiters also look for attributes beyond the discipline knowledge, which they take for granted. Commitment to life-long learning; ability to find, understand and organize information to solve problems; ability to contribute in multidisciplinary teams and the ability to effectively communicate in different formats are just some of the attributes employers expect in newly graduated engineers.

Professional skills have some characteristics in common: They cannot be taught (students have to develop them), they require constant practice to improve, and one never finishes developing them. When in their university life should students start developing these skills? The answer is from day one. Where or how should they learn them? There are two alternatives: professional skills can (and should) be explicitly embedded in the curriculum or they could be developed by participating in extracurricular activities. The rest of the paper will explore the second approach.

EXTRACURRICULAR ACTIVITIES, AN UNTAPPED RESOURCE

Extracurricular activities have always been part of the university life. Student guilds or other forms of student organizations offer a wide range of sport and cultural activities. The faculty usually pays little attention to the activities that take place in student clubs and associations because they exist outside of the curriculum, consequently these activities are considered irrelevant. However, the faculty should be aware that students who participate in extracurricular activities are more likely to rank high their university experience in satisfaction surveys after graduation (Astin, 1999). Also, studying at university can become a very isolating experience, particularly for international students or students with special needs. Extracurricular activities offer these students opportunities to meet like-minded people and make friends (Stuart et al., 2011). Furthermore, since participation in extracurricular activities is voluntary, students engage enthusiastically and willingly commit their time and resources. Are not these desired attitudes in the classroom? By participating in extracurricular activities students almost inevitably develop the skills that they attain during curricular learning experiences.

CURTIN ROBOTICS CLUB

A bit of history

The club had a humble beginning. In 2009 four students requested support from the Department of Electrical and Computer Engineering to build two small robots and an arena to participate in the iNexus Challenge, an international competition organized by the Indian Institute of Technology in Mumbai with local eliminatory competitions in different countries. The Faculty of Science and Engineering saw this as an opportunity for outreach and exposure and sponsored two students to participate in the eliminatory competition in Sydney and the finals in India. On their return the students were so enthused that they decided to create the robotics club. They were the first executive committee and wrote the Club's constitution. Experienced students mentoring new members has been the philosophy of the club since its inception. The main purpose of the club is to provide opportunities to students for learning and teaching outside the academic stream.

In 2012 Curtin Engineering allocated a room for the club in the Engineering Pavilion, a building dedicated exclusively to support engineering students' activities. This was a major boost for the club and many students started to get involved and proposed new projects. In spite of their busy agendas, members always find the time to work on their own projects or mentor students with less experience.

From a pedagogical point of view the club is not about the robots, it is about the learning (DVS et al., 2013). In the club students develop technical and professional skills like: Leadership, time management, project management, planning, teamwork, communication, logistics, sustainable design, and ethical behavior. And what is fascinating is that they learn all of these in a very subliminal way, because they have so much fun in the process. The club is open to all Curtin students and although the majority of members are student engineers, students from the School of Business and the Department of Mathematics have also participated.

Studying the impact of the club

In 2013 a research project was initiated to study the impact of the club on students' self-image, students' university experience, students' learning abilities and students' professional skills. Part of the research involves students answering a questionnaire where they reflect upon their experiences in the club. The questionnaire questions are:

1. What is your course?
2. What semester have you just completed?
3. How long have you been part of the Curtin Robotics Club?
4. What role or roles have you performed in the club either continuously or occasionally?
5. In what projects or competitions have you participated? In what role?
6. How would you describe your personal experience in the club?
7. What are the three most valuable things you have learnt in the club?
8. What abilities, if any, has the club helped you develop?
9. Has the club had any impact on your perception of yourself as engineer?
10. Would you recommend first year students to join the Robotics Club, or any other club, as soon as they start university? Why?

To answer these questions students have to reflect about the things they have learned in the club and express them in a coherent way. In second semester 2013, 14 out of 40 students answered the questionnaire. As part of the project responses will be analyzed in several dimensions: their content, their length, their style and the vocabulary used. These results will be presented in a future publication. In the following sections some of the answers and testimonials from former club members will be used as evidence to support the line of argument.

Activities

One aspect that is encouraged in the club is the interaction with other faculties. A fine example was the collaboration between a fashion student and one member of the Robotics Club. They put together a remote-controlled dress. The fashion student participated in a National Fashion Show in and the dress was very well received. Another example of collaboration happened with the Department of Physiotherapy. One member of the robotics club designed a controller for a set of electronic eyeglasses used in research. These interactions show that the club provides visibility to the work that engineering students can do. Another important outcome from these inter-departmental interactions is the confidence students obtain as a result. Confidence, the ability to recognize one's abilities and knowledge, and apply them in the solution of problems is a valuable attribute that all engineers must develop. This is what a third year student says regarding his personal experience in the club:

"Extremely helpful and insightful. Combined, the club has a variety of experiences in many areas of robotics, and allows members to socialize as well as get input on personal projects from a variety of sources. If you are doing something, usually someone understands it enough to help on it. The ability to discuss technical projects with other students and get input, and socialize around this, is one of the most useful aspects of the club, and something you are hard pressed to find elsewhere."

Another aspect of the club is its participation in internal and external events. Members of the club have represented Curtin at events organized by the local Science Museum (Sci-Tech), career fairs, Open Days, Curtin Robotics Fair and high-school visits. Club members have also represented Curtin in national and international competitions like the iNexus Robotics Challenge in India or the National Instruments Autonomous Robotics competition in Australia. In competitions students have the opportunity to meet with their peers from other universities and very soon realize everybody faces problems and issues similar to theirs. It is quite refreshing to experience the atmosphere of camaraderie and friendship that emerges during competitions. Students share their problems and exchange advice to solve them. This is the opinion of a 4th year Mechatronic Engineer mentor:

"To improve my skills and become more employable I worked hard on the FIRST Robotics Competition, and got involved in the Robotics Club, as well as Scitech and Curtin Outreach. I got better at communication, and became a tutor for Mechatronics 2nd years and 3rd. In these many roles, I believe I was able to learn how to, and demonstrate, management, teamwork, and other valuable professional skills. And so, this led me to this summer getting employment at Chevron as a Subsea Engineer - an achievement I am extremely proud of."

Currently the club has 40 members. They have a committee that organizes social events and competitions. Some of their achievements include: they obtained a grant from the Guild to buy a 3D printer, they organized a competition for the design of the Club's banner and logo, a team of high-school kids that was mentored by the club won first prize at the FIRST

robotics competition in Sydney in 2012. To attain these achievements students had to fill application forms, spend time interacting with people from different backgrounds, and conceive, design, implement and operate robots. None of these activities gave them marks in a unit, still a great deal of time and resources were invested. This is evidence that students are willing to commit and engage when activities are intellectually challenging, rewarding, fun and have a clear end. The photo in figure 3 shows some of the club members showing their creations.

Figure 3. Curtin Robotics Club members with their creations

One unexpected outcome of the club is that it has become a point of contact with alumni. Past members have fond memories of the club and are happy to participate in activities when invited. These interactions show current club members the relevance of what they do during their university years. The club has become a link with the world outside Curtin. Recently, a former club member who graduated in 2012 started a company to build robots for the oil and gas industry. He is now offering club members topics for final year projects. This is what he has to say about students who participate in extracurricular activities:

"To mitigate the risks of hiring new graduates, clubs such as the Curtin Robotics Club present us with some key points of a potential employee's capacity. A student, that took extra time out of their university schedule to pursue electronics and robotics on their own time, shows that they have a keen interest in the field. This is very desirable trait in a potential employee. In my opinion a newly graduated engineer who has participated in the Robotics Club has a big advantage in the hiring selection process over someone who has not."

Resources

Regardless of their size and function, all robots incorporate the following sub-systems: Mechanical body, control unit (computer), sensors, actuators, and power supply. Nowadays it

is possible to build a complete small, programmable robot for less than $100. This low cost has been made possible by the introduction of inexpensive single-board computers like the Arduino (Arduino, 2014) or the Raspberry Pi (Raspberry, 2014). These and other components can be purchased in several online stores specialized in robotics parts, for example: Polulu (Polulu, 2014), Robot Gear (Robotgear, 2014), Little Bird Electronics (Littlebird, 2014) and Hobby King (Hobby, 2014). These sites offer inexpensive components and deliver anywhere in the world. Robotics is no longer an expensive hobby reserved only for those with large resources.

Over the years the club has accumulated a small stock of electronic components and mechanical pieces. Arduino in all its variations is the processor of choice to control the robots. It is inexpensive, easy to program and easy to interface with small sensors and actuators. Figure 2 shows some examples of the Projects students have developed.

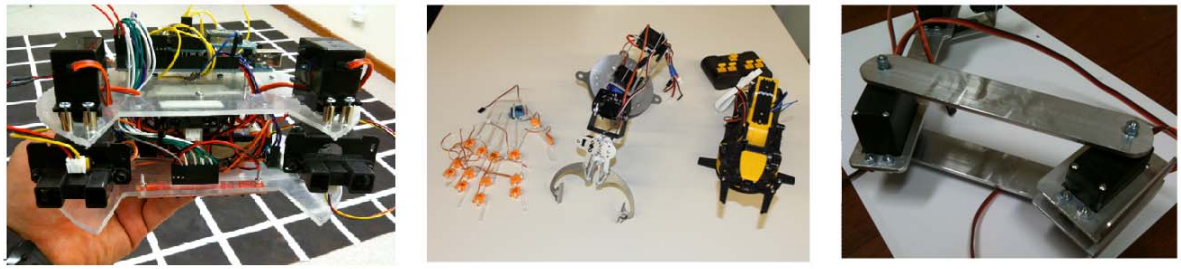

Figure 2. Examples of projects developed in the Robotics Club.

In the Club academics take the role of most senior members. They provide advice and make sure activities are carried out observing safety and common sense. Another role for academics is to manage the Blackboard website that was created for the club. This website serves as repository of information, manuals, tutorial, photos and videos.

In addition to the physical space and financial support to buy components and travel to attend competitions, members of the club also have access to a mechanical workshop, a 3D printer, a laser cutter and a group of technicians. In order to use these resources members have to make very clear to the technicians what they need, hence they need to use their communication and drawing skills. Very often technicians have suggestions based on their experience and students have to negotiate with them the best solution.

Tacit and hidden agendas

From the point of view of students the agenda of the robotics club is “there is no agenda”. This means students have absolute freedom to design and implement their robots. However, from an educational point of view there is an agenda that includes exposing students to learning experiences to develop professional skills, learn valuable technical knowledge, increase their confidence as problem-solvers, and gain a sense of belonging to the club and to the university (Anderson, 2012). This is achieved by encouraging students to reflect on what they do and how they do it, successes and mistakes. The following testimonial is from a student who graduated in 2011 and currently works for a local company designing electronic equipment for underwater communications:

“[My participation in the Robotics Club] helped me recognise that engineering requires interdisciplinary skills and collaboration. The opportunity to work in a team on a robotics project from start to finish was the foundation of my experience as a professional engineer.”

MORE STUDENT TESTIMONIALS

The following is a selection of the answers students gave to the questionnaire in 2013. They make clear that students are enjoying their time in the club and acknowledge the positive impact the club has in the development of their abilities and their confidence as engineers.

How would you describe your personal experience in the club?

"Very rewarding, good networking and learning through hands-on experience. I learnt a lot about group management and the mechanical side of things."

"Very enjoyable, great place to learn from other people and get ideas for new projects."

"My experience with the Curtin Robotics Club was a highlight of my time at Curtin University and gave me the opportunity to work in multi-disciplinary teams and to solve practical problems on real projects – an experience largely missing from university degrees."

What are the three most valuable things you have learnt in the club?

"Communication and the ability to communicate concepts appropriately, teamwork skills, and a better understanding of other engineering students."

"The spirit of 'Once you say it, you got to do it', Robot interaction with human and teamwork."

"Communication skills, management skills and learn more knowledge about technology: talking to someone who's interested in robotics just like me can learn much more than taking a unit."

Has the club had any impact on your perception of yourself as engineer?

"The club has definitely helped me to become a better engineer by letting me employ the things I have learnt in class"

"Yes, I feel it has made me a much better engineer. I am confident that I can do things"

"I personally believe the club and the work I do through FRC had a direct role in making me the engineer, and the person, I am today"

CONCLUSIONS

Universities play an important role in society by educating future professional practitioners. Students come to university to be exposed to learning experiences that allow them to acquire knowledge and develop their skills. In this paper a case was made to use extracurricular activities to get students involved in activities where they can develop professional skills and learn discipline content.

The Curtin Robotics Club has been active since 2009. In the club, members conceive, design, implement and operate small robots to participate in national and international events. These

experiences provide opportunities for students to develop important professional skills and boost their confidence as problem-solvers. All the activities in the club are planned and carried out by students, academics act only as resource providers and safety officers. In the club knowledge is transmitted from experienced members to novice members. In reflecting upon their experience in the club, students manifest their learning of technical knowledge and professional skills while gaining a sense of belonging to the club and the university.

The Curtin Robotics Club experience demonstrates that creating extracurricular activities does not have to be an expensive affair. Money cannot be a replacement for students and staff enthusiasm. In the modern context, students are always looking for new experiences. Let us capitalize on this fantastic resource!

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BIOGRAPHICAL INFORMATION

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