From printer to a robot; an introductory course for electromechanical freshmen engineer

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INTRODUCTION

Usually, most of the students who have chosen an engineer field for an undergraduate cycle and especially those who have chosen an electro-mechanical engineering think to deal with machines, invent or even build and create their own system. But early and just after their first sessions, student discover that they have to deal with heavy equations and a lot of theoretical formula, they ask all the times “what is useful for?”

These reasons could demotivate students and badly affect their education. In addition, and according to Edgar Dale’s cone of learning [1], people are able to remember 90% of what they do “some thing that you can get your fingers on” and only 10% of what they hear. To cope with this problem, some university give an introductory course, most often a project based-learning that strengthens the

motivation of students and at the same time let them learn by direct participation in order to enhance their skills. Such alternative project may prepare better the student to the career they aspire [2].

The idea was to build a line follower robot in a different way, students have to disassembly an old printer, understand how it works then find similarity with the robot and finally use the recycled pieces to build the robot in order to fill in the lack of components and stimulate the interest of student for the eco-design.

The following paper will give more details on the objectives of this course and will describe the method to implement in the project. Next, section 3 will list the student's feedback and their opinion about this new kind of project, the method of teaching will be evaluated and discussed for enhancement and possible integration in other courses.

1 OBJECTIVES OF THE TEACHING

1.1 Content

As it is an introductory course for the electromechanical engineering branch for freshman, we choose to introduce for the optic wave course by focusing on the infrared light sensor and by the different type of motor for the course of the electromagnetic wave. The course of computing science and electronic circuit was covered by the use of transistors. Finally, some mechanical aspects like the speed ratio for a geared system has been tackled.

1.2 Learning outcomes

By the end of this course student should be able to:

Know how to use different tools and equipment available in our labs.

Make the difference between the wave's length of both visible light and infrared light.

Know the colour's properties of infrared light reflection.

Know how to use transistor and adapt it into a circuit.

Determine the relationship intensity/torque and voltage/speed for a DC motor.

Determine the speed law of a geared system.

Know the difference between torque and power

1.3 Challenges

The biggest challenge in this course is to deal with the lack of appropriate material while keeping the student's motivation during the course. In addition to the objectives above we aim to prompt student to collaborate and work in groups. We also focus on developing practical work and gaining hands-on skills.

2 IMPLEMENTATION

The course "initiation for electromechanical" was given to two classes of freshman in the first semester for a total duration of fourteen weeks spread over three-hour sessions per week and was given in both mechanical and electrical labs. Two trainers, mechanical and electrical engineers led the sessions. The biggest challenge was when forming the teams to work into a group, the criterion was to form groups as heterogeneous as possible so that the less confident students could learn how to solve problem from the stronger ones, the latter could also improve their knowledge.

The first three sessions were booked to the printer disassembly phase. The objective was to understand how the printer does work by asking two questions; why is this component here? And how does it work? Through the explanation of the trainer students were prompted to find or detect similarity with the line follower. It was easier than explaining directly how to build the robot and at the same time, it aims to arouse their imagination.

Recycled components were mostly infrared light sensor, different types of motors, different sizes of gears, printed circuit and a lot of plastic waste. Each of this part, except the printed circuit and the plastic, was the subject of several experiences for the following sessions. The most amazing experience is that when student used their smartphone camera to visualize the infrared light that they were unable to see with the naked eye because human vision is limited to the light with wavelength between 400nm and 700nm.

Starting the 7th session, each team was divided into mechanical group and electrical group, to create a kind of positive interdependence, interactive cooperation and engagement was adopted. Student must believe that they are linked with others in a way that one cannot succeed unless the other members of the group succeed and vice versa. In other words student should feel that they sink or swim together [3]. The mechanic group was assigned to create the robot frame and fix the motors and wheels. However, the electrical group was affected to deal with the sensor and the circuit that will drive the motor. That way each group will be obliged to communicate and rely on one another to achieve building the robot, else the fail of one group will cause the fail of all the team. Figure 1 shows a flowchart of the project (robot building).

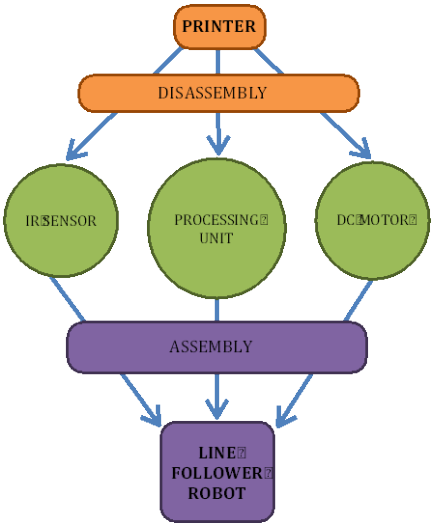

Fig. 1. Flowchart of the robot building

A qualitative assessment was adopted to evaluate the learning outcomes in the last sessions. The qualitative assessment does not directly address the question of “how much” the student knows, but “how well” [4]. The final assessment was an oral presentation where student shows their robots and the different stages of work starting from disassembly until building the entire robot. The “how well” being expressed not in marks but in hierarchy of level such as letter grade form “A” to “D”

[4]. In all case there was no “F” level because even those who didn’t finish building, they were able to answer the oral questions relating to the learning outcomes.

3 STUDENTS FEED BACK AND DISCUSSIONS

Four month later, the student who has attended the course was asked to answer some questions about that course. There were two types of questions, pedagogical questions about the teaching method and technical questions in relation with the learning outcomes to know how much of knowledge was retained, here are some of the findings learning method. The results showed that 100% of students were satisfied about the teaching method. Therefore all students wish to extend this type of project to other disciplines. 73% target electronics due to the experiments carried out in the electronic lab during the project and similar to that learned in the electronic course. This interest is mainly due to two reasons; the first is that 80% of students say they have exploited the knowledge acquired during the project in other courses by the conventional teaching method. The second is the agreement of all students on the usefulness of the activity carried out during the project as manipulating tools and equipment in their real life. 78% of students prefer being evaluated by an oral presentation against only 22% who prefer the classical written exam.

4 CONCLUSION

Project based learning, as an introductory course for electromechanical engineering, was very interesting in terms of motivation, student’s attraction and learning outcomes. Student got used to such kind of projects and especially with robot project which present an attractive target due to its multidisciplinary aspects. Furthermore, printer was used in a sustainable way and given a second life by students. A total involvement of students was observed through their issues, however some shortcoming in communication and teamwork was disclosed by this project.

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