A WORKSHOP COURSE TO RECONCILE KNOW-HOW AND KNOWLEDGE IN THE FIELD OF TECHNOLOGY (CASE OF LEBANESE HIGHER EDUCATION)

Saliba Marie-Thérèse, Eng., PhD
Montréal University, Canada

Abstract
        This action research addresses issues related to the skills in higher education in order to provide transferable skills and employability in engineering and technological fields. This research aims to offer a practical guide to effectively integrate skills into first year engineering courses. It is in this spirit, and in the context of Lebanese Universities that we conducted a reflection and an experiment around the design of a learning environment project (Project Approach) as a solution to the fragmentation of subjects in science and technology. We report in this article the problems observed in teaching in Lebanon before presenting our solution (Project Approach), its foundations and put it into practice around the creation of a robot. This study was conducted with 80 first year electrical engineering and computer science students at a Lebanese university.

Keywords: Lebanese Higher Education, Science, Technology, Project Approach

Introduction
        The teaching of technology still suffers from a fragmentation of knowledge. Worldwide, there has been a fall in the number of university students in sciences and technology according to a several studies on this field (Graham & David, 2003 UICEE) and (Ginestie, 1999).
        With the aim of creating a new relationship between knowledge and know-how in order to improve professional skills and encourage sciences and technology interest, we can embrace different concepts related to learning such as, constructivism (Piaget, 1969), socio-constructivism (Vygotsky, 1934), conectivism (Siemens, 2005) and competency-based approach.

On the other hand (Inshauspe, 1998) and (Vivet, 1990) assure that the new approaches by competency require a profound change in learning activities in science and technology.

Students should be more active, more independent; they have to be involved in a scientific investigation in the laboratory in addition to the lectures from a classical education. Hence, I think that, an action based approach through a collaborative project allows students to build trainable capacities consistent with the expectations of society and enables them to integrate their knowledge.

In this research, in order to demonstrate how the action-based approach is essential for the integration of knowledge and know-how. We have conducted an experiment through a university level course encompassing 80 first year engineering students, from different backgrounds in relation to their usage of technology equipment. The aim was to homogenize the different students in order to be able to achieve a balance of Knowledge and know-how.

Observation on teaching technology

In this section, we will present an overview of technology education in Lebanese schools and universities.

Observation on current teaching of technology in schools

The huge problem starts in our schools. In fact, following the CERD[54] national program, the teaching of technology still retains its status as an "activity/club" and is not involved in any evaluation in official examinations.

According to the CERD, slightly modernized from thirty years till now, technology is reduced to an application of the science, e.g. sciences refer to the lectures for theoretical presentation and technology to laboratories activities as an experimental support. In general, the CERD reduces technology to practical classes in science education.

Even though the CERD imposes one period per week of technology from the elementary to the secondary cycle, the lack of budget to implement specific laboratories in chemistry, physics or even with computers prevents the majority of Lebanese schools, particularly the public ones to fulfil this requirement.

In fact, although some private Lebanese schools dispose equipped laboratories, they are hugely limited to the demonstration of experiments by the teacher in order to reduce time consumption: They prefer dedicate the allocated period from laboratory activities to their lectures in sciences, which

---

[54] http://www.crdp.org/en :Center for Educational Research and Development (CERD)

is required in official examinations[55]. This situation degrades the interest of the pupil in technology and takes away the constructive goal of experimentation.

Other schools, which do not dispose of well-equipped laboratories, are content with lectures without any sort of experimental support. This later leads to a students' lack of capabilities in various technological disciplines at the university.

Knowing that, to adhere an engineering, technology or science specialization at most Lebanese universities, pupils must succeed, among other requirements[56], a baccalaureate in General Science (GS) or Life and Earth science (LES) which in fact do not have a laboratory component.

Observation on current teaching of science and technology at Lebanese Universities

As an electrical and computer engineer I have assumed several academic and administrative responsibilities at the Holy Spirit University at Kaslik – Lebanon at the Faculty of Science and Computer engineering since 2000.

During this period, I have examined most of the engineering and science programs in five of the most famous Lebanese universities[57]. I have found that, most courses use the same teaching model which consists of 3 hours of theoretical presentation per week in addition to 2 hours of practical work in laboratories. The portion of laboratory work allows exclusively to apply and deduce the theories viewed in class. This laboratory session is performed under the supervision of the teacher and strongly guided by a manual. Students perform experiments by following an experimental protocol previously established. The learner is no more the holder of his education and consequently, he loses his autonomy.

Following (Perrenoud, 1998):

"This approach moves away from constructivism and competency-based approach whereby the student becomes responsible for the acquisition of knowledge and organization. These should not be limited to a set of procedures and content to be memorized. The integration of learning is, first: Related to the gradual creation of a coherent whole from knowledge, skills

---

[55] In exception to the private schools which maintain a double baccalaureate: the Lebanese one with the French (BF) or the International Baccalaureate (IB).

[56] Most of Engineering and Science Faculties impose an oriented entrance exam in addition to the baccalaureate in GS or LFS.

[57] Holy Spirit University of Kaslik (USEK), Saint Joseph University (USJ), Lebanese University (UL), Lebanese American University (LAU) and American University of Beirut (AUB).

and attitudes, and secondly: The implementation and the use of newly acquired skills in different situations."

Perrenoud says that by limiting teaching to a set of procedures to be memorized, we condemn our students to be closely dependent on us as teachers and mentors. They will be no more responsible for their own acquisition of knowledge. For this author, the integration of learning is based upon: Learning to know and learning to do in new situations.

The heterogeneity of students in their technology activities at the University

According to the above, the students behave differently during the first academic year, from the standpoint of their prior knowledge and know-how. As a teacher, I must consider this disparity in order to plan activities that meet the benefit of all.

I have noticed that the integration of students, coming from a magisterial education is difficult: They slow the progress of their well-formed colleagues in laboratories fields. For the sake of safety during the experiments, the risk of accidents increases because of lack of maturity in the group work.

"We need to break a major paradox: A uniform teaching with a heterogeneous class. Instead of a uniform education where the origin is the teacher, we will design a non-uniform teaching with the student as a central player" (Boudreault, 2003).

Boudreault suggested breaking the traditional way of teaching by subdividing students according to their educational level and consequently assigning an adequate project.

Pedagogical / educational foundations involved: Action learning approach through a project

Unlike most educational subjects, science and technology require, in addition to their theoretical content, the appropriation of functional devices in laboratories (Jowallah, 2008).

To remedy the complications found in science and technology education in Lebanese universities, I suggest the development of an environment of action learning via a collaborative project in laboratories. This tangible learning would allow the student to develop a structure of thought that is more formal while making him more autonomous with the acquisition of knowledge (Akınoğlu & Özkardeş, 2007).

This strategy is inspired from the social constructivism approach. It engages students in solving scientific problems as part of a research project team. It is similar to that adopted in industry.

In this context, as a teacher, I act as an arbitrator fragmenting tasks, I only occur to resolve problems. However, the student learns by organizing his own experimental protocol. Then, I could test the student ownership of an experimental expertise while integrating disciplinary knowledge rather than memorizing them. I am also responsible for guiding my students to the adequate scientific revues and web sites.[58]

By engaging my students in scientific investigation, I hope that, they build knowledge (constructivism) and they are thus able to invest them in the field of labor. (Wills, Dermer, McCauley, & Null, 1999) used the term of "peer learning" to encompass collaborative learning. They presume to touch a better understanding of the problem and students are more active and engaged in their learning[59].

Description of the context of the work-shop course: Proposed learning environment in Science and Technology

I am aware that a learning environment should reflect a real situation, its goal is to enable learners to transform their experiments into know-how in a quick and efficient way.

"The idea is that to move from a paradigm where the system was a communication system and where we saw the teacher as a producer and the learner is only a receiver, to a system where the student is an actor in his own learning." (Giardina, Depover, & Marton, 1998).

In this citation, Giardina finds that it is important to change our strategy in teaching from a teacher centered status to a student centered status.

As a member of the programs committee in the Holy Spirit University of Kaslik, I have introduced innovated courses in the first year in engineering and science education, the aim was to help students to adopt a scientific approach, to be familiar with technological tools and especially, to homogenize the differences in their experimental expertise.

Among these courses, a specific workshop- course titled "Electronic Project" (ELE335) was held and I was responsible to develop its content as well as implement it. This situation is similar to the "action learning strategy" (Johnson, 1998).

Description of the organization of the work-shop course

In the work-shop course, the students will be engaged in an activity where they can freely design solutions and get used to the field of professional market. As a trainer, I am always present in supporting and promoting a process of active learning.

---

[58] www.solorb.com; www.alldatasheet.com; www.electronics-lab.com; Revue Electronique pratique

[59] The research findings from two workshops (workshops in June 96 and June 97) at Worcester Polytechnic Institute (WPI).

This project is divided into modules that must be completed within a realistic time frame. During this work-shop course, students have to:

- Draw electrical schematics,
- Make circuit simulation[60],
- Implement circuit wirings,
- Research materials on the market, etc...

The 15 week organization deals with peer's interactions, which is the heart of all pedagogical organization based on student centered learning. Many research brings to light interesting and relevant outcomes on the interactions among teachers, students and knowledge; at this moment, they constitute the most pertinent scientific contributions to science and technology education (Smith & Cardacioto, 2011) and (Race, 1993).

This workshop course requires two hours per week during fourteen weeks; the fifteenth week is devoted to present the project as a Word document and in Power Point. This presentation is open to a debate with the public (Peer observation). Knowing that the public could be other teachers or groupes' colleagues.

Description of the students' activity, their outcomes and feedback about the work-shop courses

The course objective was to manufacture electronic circuits chosen by the students. At the end of this course, students should be able to make a circuit through the use of a pre- manufactured issue, understand the components and their characteristics offered by the manufacturer's Data Sheet, and write a scientific report of implementation with an oral presentation in PowerPoint.

This workshop aims to make first year students familiar with the laboratory equipment and the commercial market. In addition, they will be able to acquire skills to communicate as a group (socio-constructivism).

Choice of the group

Students are to be freely paired up. As a teacher, I am careful to ensure homogenous groups. Because Science education is based on the argumentative field, this environment needs an educational atmosphere suitable for coordination and communication among the group members.

In this workshop, I consider an aspect of the "theory of situations" of (Brousseau, 1998); I must allow students "to build new knowledge".

In his ouvrage, Brousseau wrote:

"Devolution is the act by which the teacher makes the student accept responsibility for a learning situation (a- didactic) or a problem and accepts, himself, the consequences of this transfer."

---

[60] Examples of simulation programs : Pspice and Multisim Electronc's Workbench

Brousseau claims that the hidden objective of an "a-didactic" situation makes the student responsible for his learning. This author introduces the idea of the job of a student, which is to live up to the expectation of the teacher. Since this theoretical description of interactions among teachers, students and knowledge is in accordance with the dynamic process of teaching-learning.

Choice of the project

The project, plausible and affordable, is not necessarily unique for all the class neither imposed by me as a teacher. I present to my students a list of websites and scientific documents. Each group chooses a circuit of his pick and knowledge levels. Since the topics are diverse, the criteria for my approval are diverse as well:

- The plausible and the scientific objectives
- The degree of ability to show the previous concepts and emerge new ones
- The level of complexity that stimulates creativity
- The availability of components in the local market
- The investment of the peers in this activity

(Vergnaud, 2000) proposed: "The organization of the disturbances, in order to cause learning". Although the subject is not completely designed by the student, its complexity can generate innovation and creativity and evoke a "cognitive leap".

The implementation of projects [61]

By implementing projects, the learner explores the situation, considering solutions through a process of "trial and error". (Race, 1993) in his "Ripple models" advanced that teachers must keep students learning by doing, practice and trial-and-error.

Learning depends on the richness of the educational environment, where students are placed with instruments, documents, etc … Developed by me as a trainer.

Training will be faster when learners are free and motivated to act (Smith & Cardacioto, 2011). This assumes they have a cultural body efficient enough to act responsibly. Here, the prerequisite courses required are: basic electronics and electrical circuit. This knowledge was exploited to make them understand, through their personal efforts, the actual use of circuits in an industrial field.

---

[61] You can find any further information (videos, photos, reports, ..) on this project on the address of the author marie-therese.saliba@umontreal.ca

An application example: The realization of a robot

One such project- workshop, I really enjoyed, was the realization of a robot. As its name "Line Tracking Robot" revealed (see Picture 1), the robot must follow a black line by making corrections to its trajectory in order to reach its destination.
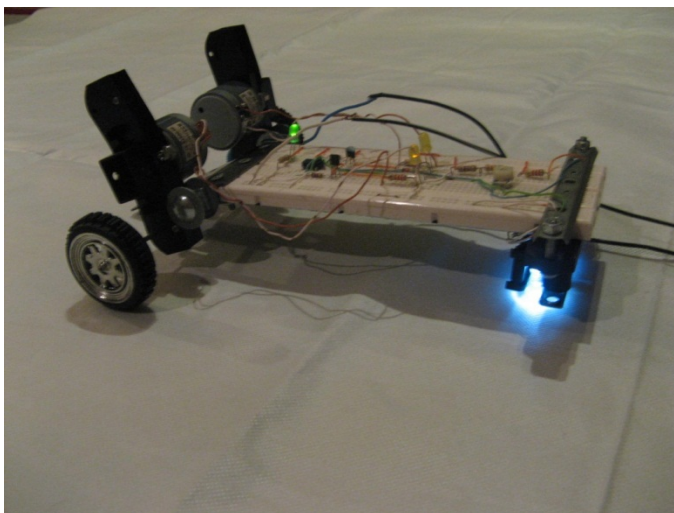
Figure 1 : Line Tracking Robot

The goal of realizing such a project is to visualize the operation of electronic components (LM393, photo resistors, transistors ...), use simulation software, practice building circuits, test and eliminate errors (engine speed, brightness of the field ...).

The project implementation occurred in sequential steps: Construction of the electrical part, then adjustment of the potentiometer to balance the voltage across the photo resistors. The result is perfect. However, at the level of the realization of the mechanical part, the problems appeared: Reduced wheel friction and improving the operation of engines. The motors required poor Intensity 0.6A to start, so students substituted them by toy cars motors.

Students' feedback:

According to the report presented by my students, the development of this project has offered them several advantages detailed in their reports below.

Students' report on "line tracking robot":

• "The choice of the pair was free; we must take into consideration the place of residence of each to facilitate cooperation and achieve our goal. The choice of the project "Line Tracking Robot" was fun. This robot did not cost too much. All the necessary materials for its construction were available".

This reveals how the students have become more familiarized with the market and have enjoyed their learning experience which enhanced their self-confidence.

• "This project aimed to familiarize ourselves with the various tools and electrical components". This shows the students have become well acquainted with the material at hand.

• "We have gained more experience, our technical competence is enriched and our method of working has changed". This point proves that students are now more competent in their work in the laboratory.

• "It is through the right choice of group work that the project offered us several advantages: The distribution of tasks, saving time, sharing knowledge, opinions, etc…"We can see here that management of tasks between the students became more efficient as the lab work went on.

• "Group dynamics: In a group we feel stronger and we encourage one another".

• "Group work is far from a magic formula that works every time, so it will never replace the personal work!"

• "Acquaintance with the resources: Books, websites …"

• "What is conceived well is expressed clearly": We train ourselves to play the teacher and test our ability explaining."

The points above were some relevant opinions of the students, revealed by their own authentic style in French in their final Word report then it was translated into English by myself.

In summary, we see that all of the above points, made by the students, have been at the foundation of better understanding, management and even self-confidence within respective teams based on a student's own personal know-how and knowledge integration.

The students' feedback, their motivation during the workshop and their questionnaire responses, incited us to presume that the pedagogy of projects in the labs leads students to take responsibility for their learning. Indeed, students are enthusiastic to get their own experiences. They acquire confidence and develop skills and know-how.

(Leroux, 2005) believes that: "In an educational project situation, students require both knowledge and know-how."

I realized that, working in teams students learn to follow rules and timelines. They learn to read data sheets, to interpret and to structure their work.

By Internet research, students can navigate through a magma of information in order to expand their knowledge, sort and draw concepts needed to approach their projects. Sometimes, they are led to confront and

negotiate contradictory concepts, analyze and come out with decisions and conclusion.

While carrying out the project, students will be able to modify and correct their models by feedback after seeing results. This phase designated "levels of correction" is pertinent to the development of scientific criticism.

"This project-based approach leads to the acquisition of knowledge, especially in the action of problem solving. Rather than teaching a theoretical method, it gives the student the opportunity to implement it so that it can be integrated in all his training approach" guaranteed (Leroux, 2005).

Many authors e.g (Smith & Cardacioto, 2011), (Jowallah, 2008), (Graham & David, 2003 UICEE), (Wills et al., 1999) and (Race, 1993) advocated that, group work provides an opportunity for students to integrate knowledge and to transfer them.

Impact of the workshop- course

Setting student on collaborative projects activities to build skills transferred later into industry, converges to the line of constructivist and social constructivist theories developed by (Piaget, 1969), (Vygotsky, 1934) and (Wallon, 1937).

From my own experience in the field of science and engineering teaching added to many researches in this domain (Jowallah, 2008) and (Akınoğlu & Özkardeş, 2007), I believe that the project approach provides for both, students and teachers, several benefits:

Advantages for the students

At the end of the 15 workshop sessions, we launched a survey in the form of a questionnaire for the 80 students involved to view their opinion on the course-workshop and group work. This survey will evaluate the level of the enthusiasm felt by the students towards this project based approach.

Table 1 : Questionnaire

Survey	Agree	Don't agree
1-Team work has enriched our technical and scientific knowledge	63.3 %	36.7%
2- We gained in time by distributing tasks	80%	20%
3-Team work allowed us different opinions diffusion	73.3%	26.7%
4- The team communication has been ratified	86.7%	13.3%
5- The group dynamism solicited our integration in the project	76.7%	23.3%
6- When problems occur, we do know the causes (software, hardware, experimental protocol, etc.)	90%	10%
7- The course-workshop is interesting because we see the tangible part of the physical phenomenon	90%	0%
8- During the workshop, the creation of a technological working object was validated	100%	0%

From the questionnaire responses we took away students' appreciation for the collective work. It appears that this strategy has brought satisfaction in terms of minimization of working time, distribution of tasks, exchange of knowledge, the development of their auditory function to listen to and respect the views of all the other defending them. They are required to negotiate and confront sometimes contradictory concepts, analyze and conclude with a decision (skills). These numerous exchanges, returns, attempts, discussions and interactions promote efficient distribution of tasks. It should be noted that, this survey is merely a subject based evaluation, it cannot be generalized and cannot reflect the overall efficiency of our approach.

Advantages for the teacher

In a workshop situation, I could act as a coach, a referee and a manager. I assume that, this context has freed me from the classical situation of a knowledge transmitter.

Since the beginning of the course, I have organized teams to ensure that members are homogeneous, which puts me in a favorable position to assess the work of each member to follow the schedule, plans, timelines, write reports and account-presentation of the project. This organization relieved me of formative assessments, as the work is done by stages in a well-defined period of time.

Barriers of the workshop- course

This workshop represents a polyvalent problem: Seeking an integration of materials, a methodology for group work, communication, negotiation and decision making as well as a certain social maturity.

In collaborative work, difficulties arise. The most important are the organization and the composition of the team considering the ability and motivation of each student and especially the load of problems to face.

My initial objective was to harmonize previous knowledge of students, which showed to be a real challenge in choosing the peer members and the subject matter. According to (Boudreault, 2003), the solution to consider is "breaking the paradigm of homogeneous teaching for a heterogeneous class".

On the other hand, this form of learning is costly in terms of time and materials, which greatly limits its application. It requires smaller classes, more assistants, equipment, research papers...

For some teachers, moving from traditional pedagogy to this new one is risky and could be complicated. In fact, most teachers have themselves been trained by a teacher centered approach. They feel comfortable in this model.

Conclusion

I undertook this study to deal with the fragmentation of disciplines and to encourage involvement in science and technology specialization.

I presented the solution through a collaborative project approach in the laboratory: A workshop course promoting an active involvement of the students by implementing their personal analysis related to a professional technology approach. As a result, I have noticed that my students, having different backgrounds, have become homogeneous and are now working in a more active and efficient way.

I could conclude that this strategy increases continuity of content in a course, supports the connection between the different disciplines making a break with routine curriculum, which segment disciplines in scattered and purely theoretical courses. This conclusion is strongly supported by my students' feedback, the specific survey and their development of professional skills throughout this course.

References:
Akınoğlu, Orhan, & Özkardeş, Ruhan. (2007). The Effects of Problem-Based Active Learning in Science Education on Students' Academic Achievement, Attitude and Concept Learning. *Eurasia Journal of Mathematics, Science & Technology Education,, 3(1), 71-81, Copyright © 2007 by Moment*(Tandoğan, Marmara Üniversitesi, Istanbul, TURKEY, Received 07 June 2006; accepted 12 November 2006).

Boudreault, Yves. (2003). *Conception et développement d`un environnement favorisant l`apprentissage des concepts fondamentaux de la programmation.* (PhD), Monréal- Université de Monréal.

Brousseau, Guy. (1998). Théories des situations didactiques: Didactique des mathématiques. In L. P. Sauvage (Ed.), (pp. 395). Grenoble.

Giardina, M., Depover, C., & Marton, P. (1998). *Les environnements d`apprentissage multimédia: analyse et conception*. Montréal.

Ginestie, Jacques. (1999). *La démarche du projet industriel et l'enseignement de la technologie*. Paper presented at the Séminaire de didactique des disciplines technologiques.

Graham, Hills, & David, Tedford. (2003 UICEE). The Education of Engineers: the Uneasy Relationship between Engineering, Science and Technology. *Global J. of Engng. Educ.,Published in Australia, Vol.7, No.1*.

Inshauspe, P. (1998). Les programmes d`études : Essayons d`y voir clair. *Pédagogie Collégiale- Montréal, 12*(1), p.8-14.

Johnson, Craig. (1998). The essential principles of action learning. *Journal of Workplace Learning, Volume 10 · Number 6/7*(© MCB University Press ·), pp. 296–300.

Jowallah, Rohan. (2008). Using technology supported learning to develop active learning in higher education: A case study. *US-China Education Review, Volume 5, No.12 (Serial No.49)*((School of Education, University of Wolverhampton, Walsall WS1 3BD, United Kingdom).

Leroux, Pascal. (2005). Reflexion sur la conception et l`utilisation d`environnements informatiques supports d`une pédagogie de projet pour l`apprentissage de la technologie. *Res Academica, 23(2),*(5eme collogue international sur la robotique pedagogique), 143-168.

Perrenoud, Philippe. (1998). Cyberdemocratisation. Les inégalités réelles devant le monde virtuel d`internet. *La revue des échanges, 15*(2), p.6-10.

Piaget, J. (1969). *Psychologie et pédagogie*. Paris: Denold.

Race, Phil. (1993). How Students Learn *A Review of Some of the Main Theories- Centre for the Enhancement of Learning & Teaching*.

Siemens, George. (2005). A Learning Theory for the Digital Age *International Instructional Technology and Distance Learning.*(janvier 2005).

Smith, & Cardacioto. (2011). Is active learning like broccoli? Student perceptions of active learning in large lecture classes. *Journal of the Scholarship of Teaching and Learning, 11*, 53-61.

Vergnaud, M. (2000). *Pédagogue et penseur de notre temps*. Paris: Hachette, éducation.

Vivet, Martial. (1990). Learning with micro robotics activities, in integrating advanced technology into education. *spring verlag, 78,* 139-148.

Vygotsky, L. (1934). *Pensée et langage*. Paris.

Wallon, H. (1937). Psychologie et éducation de l`enfance, buts et méthodes de la psychologie. *In Enfance- Spéciale*.

Wills, C.E., Dermer, D., McCauley, R.A., & Null, L. (1999). Studying the use of peer learning in the introductory computer science curriculum. *Science Education, 9*(2), p. 71-88.