LEARNING AND MOTIVATION BASED IN PROJECT METHOD: COOPERATION PROJECTS AND EDUCATION IN VALUES

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Tell me, and I'll listen
Show me, and I'll understand
Involve me, and I'll learn
-Lakota

ABSTRACT
The present communication shows the methodology used, and the results obtained in an educational project framed in the field of the education in values and democracy education. This educational project pursues to improve the academic results of the students in secondary schools by means of the motivation that provides them the work in cooperation projects and socially responsible projects. This project has been being developed for several years by the Non-governmental organization "Ingeniería Sin Fronteras Aragón" in collaboration with professors of the University of Zaragoza (Spain) and professors of secondary education. We have developed a methodology that enables us to tackle the contents of different subjects in the curriculum using activities and practical works based in projects. The cooperation project is centred in the problem of deficiency of energy in Saharawi refugee camps in the Western Sahara in Argelia. The scenario which involves working with cooperation projects provide an extra motivation for students during the learning process and enable us to develop the selected learning activities and achievement of the learning objectives. This methodology also allows the participation of the entire education community in the teaching/learning process and motivates the students to improve behaviours in schools.
Keywords: Motivating Students, Problem-based learning, Education in values, Democracy Education, Development co-operation, Human Rights Education, The Western Sahara.

BACKGROUND

Decrease of engineering workforce

The decrease of engineering workforce is a problem that Spain shares with other European countries and with the United States (Bagiati, Yoon, Evangelou, & Ngambeki, 2010). As Spain faces a shrinking engineering workforce (Capilla, Hervás, & Soriano, 2008), the percentage of young researchers working in the technical areas decreases as can be seen when analyzing the results of the several research reports (Aceituno, Campanario, & Burgos) (Ministerio de Ciencia e Innovación, 2008) (INE, 2011) (OCDE, 2009) (Alemany, Alvarez, Planellas, & Urbano, 2011).

A further unresolved problem relates to the absence of associationism through young people, in (Vázquez, 2011) Rafael Vázquez offers a comparative perspective of young volunteering regarding to other forms of conventional and non-conventional sociopolitical engagement.

The causes of the lack of initiative and entrepreneurial culture include, according to (Alemany, Alvarez, Planellas, & Urbano, 2011), a related fear of failure, a lack of confidence and self-assurance, limited creativity and the fact that many students are unaccustomed to work in group projects and may feel uncomfortable participating in or initiating group discussions.

To enhance young people engagement, associationism and entrepreneurship, a change in educational methods is needed.

Traditional educational strategies, such as lectures, lab practice, and homework, have been criticized because they inadequately prepare students to engage in collaborative partnerships. Especially in

engineering studies these methods promote passive learning and a compartmentalized curriculum that may not prepare students for the innovative and flexible role of engineers in today's society.

Spanish Curriculum vs. Massachusetts Curriculum

One of the most prestigious engineering curriculum (Douglas, Iversen, & Kalyandurg, 2004) is the "Massachusetts Science and Technology/Engineering Curriculum" (MST/EC) (Massachusetts Department of Education, 2006). A concept maps have been used to align the Massachusetts Science and Technology/Engineering Curriculum with the Spanish engineering curriculum. As curriculum comparison method, a mapping strategy has been used to create a template concept map of both curriculums, and this has enabled a comprehensive comparison of both curriculums. Analyzing the contents of Spanish engineering curriculum from kindergarten to 12th grade (K-12), and comparing these contents with MST/EC, we find them very similar. In fact they agree in more than 76% of the contents.

A curriculum is a framework that sets forth the program's philosophy, goals, and objectives, as well as guidelines for teaching that address all aspects of the student development. The comparison has shown that the Spanish curriculum is similar in content to the Massachusetts', but has also shown that there are huge differences in methodology especially in the guidelines proposed by Massachusetts.

Educational methods

K-12 STEM (Science, Technology, Engineering, and Mathematics) education in Spain has appropriate contents for engineering education from pre-kindergarten to grade 12. But the education system in Spain does not address the need of preparing teachers to incorporate engineering education into their practice with the correct methodology to tackle the STEM contents. Engineering education in K-12 classrooms has a number of opportunities for STEM learning, but also raises questions about knowledge and professional development, and poses challenges such as institutional curriculum standards and assessments of major importance.

The goal of the Guiding Principles, included in the MST/EC, is to help educators create inquiry-based educational environments that encourage student curiosity, engagement, persistence, respect for evidence, and sense of responsibility. However, MST/EC has also suggested learning activities referred to the related grades (from kindergarten to 12th grade) for each subtopic of the learning standards.

An effective program promotes high academic expectation for all students, investigation, experimentation, collaborative learning, project based learning and problem based learning. The methodology proposed by Massachusetts promotes these learning activities including such varied initiatives as "Project Lead the Way" (www.pltw.org/aindex.htm), "For Inspiration Recognition of Science and Technology" (www.usfirst.org and mindstorms.lego.com) or "RepRap Project" (reprap.org).

Learning engineering content must be as close as possible to the work carried out in real engineering projects. Students need opportunities to work with peers and to talk about their work in focused discussions with peers and with those who have more experience and expertise. Students also require practice in making written and oral presentations, responding to critiques, and developing replies.

Collaborative learning benefits

Some of the benefits of collaborative learning and project based learning are that theses methodologies allow identifying gaps in knowledge among students while encouraging the development of knowledge (Stump, Hilpert, Husman, Chung, & Kim, 2011) (Yadav, Subedi, & Lundeberg, 2011). But also, for those interested in the social aspects of learning, effective collaboration simultaneously serves the goal of equity of students while working with peers. Regarding the cognitive aspects of learning, these methods involve a better conceptual learning to attain higher order thinking.

PORPOSED METHOD

We have developed a methodology that enables us to tackle the main concepts of MST/EC using activities and practical tasks based in projects of cooperation for development that carries out the Non-governmental organization "Ingeniería Sin Fronteras Aragón", which has been developed for several years in collaboration with professors from the University of Zaragoza (Spain) and secondary education teachers. By mean of the use of learning project method it is possible to introduce not only engineering contents but also values. In this case, the cooperation project is centered on the problem of deficiency of energy in Saharawi refugee camps in the Western Sahara in Algeria.

Besides the benefits of project-based learning and collaborative learning, the methodology proposed also adds student motivation, motivation provided by their work in cooperation and socially responsible projects. This methodology also allows deepening equity of students, in their education in values and in democracy.

The projects have been taken into practice with students from 6 to 12 years old, grading their difficulty and adapting the task to age and specific purposes (depending on context, social extraction, and so on). The aim of the work is to allow students in early stages to learn a base technology contents useful to their future and, at the same time, useful to other people with disadvantages. The final goal of the project is itself, a motivation factor for students.

The method starts proposing students a project and then organizing the group to realize it. Some topics are involved in the progress of the creation as well as values. Even the problems are used to emerge new topics and possibilities. Once the project is finished, all the students make a survey to know the opinions and learning they get of the process. The impact in students will show the benefits this kind of learning could give.

Development cooperation project

The name of the development cooperation project is "The sun of Dajla". The objective of the project is to improve the quality of the energy facilities in the refugee camps in Western Sahara. This is the reason why Ingeniería Sin Fronteras Aragón has been working in the development of technologies for its transference the Saharaui community, in collaboration with professors from the University of Zaragoza and CIRCE foundation.

The cooperation project has direct and indirect actions resulting from an analysis of the reality raised by members of the association, displaced people and saharauis. Some of the direct aid consists of the electrification of health centers, building schools or installation of water pumps that work with solar energy (Pastor, Artigas, & Villen, 2009). The project also contemplates formation programs and campaigns/activities to raise public awareness in schools, in schools for women and technical training for workers. In addition, the project is working in the creation of an energy department dependent of the ministry of transport of the Saharaui Arab Republic government.

Projects defined for the learning standard subtopics

This multidisciplinary project gives us a scenario where we define and develop many learning activities and engineering materials to study the main subtopics of the Technology/Engineering learning standards of Massachusetts Curriculum: Engineering Design (SbT1); Construction Technologies (SbT2); Energy and Power Technologies—Fluid Systems (SbT3); Energy and Power Technologies—Thermal Systems (SbT4); Energy and Power Technologies—Electrical Systems (SbT5); Communication Technologies (SbT6); and Manufacturing Technologies (SbT7); Materials, Tools, and Machines (SbT8); Transportation Technologies (SbT9).

Table 1 and Figure 2 show some of the learning activities and engineering projects designed and the subtopic of MST/EC related with the activities:

Table 1. Some of the learning activities and engineering projects designed

PROJECT	Subtopic (SbT)
Design a communication network with satellite connection in a Saharaui school	SbT 6
Design and manufacture of solar toys	SbT 1, 4, 5, 7, 8
Design and manufacture of solar cookers (box, panel, parabolic…)	SbT 1, 4, 7, 8
Design and manufacture of solar water distillers	SbT 1, 3, 4, 7, 8
Electronic charge controller design	SbT 1, 5, 7, 8
Electric solar panel installations	SbT 2, 3, 4, 5, 8
Design and implement a residential windmill installation for electricity	SbT 2, 3, 4, 5, 8
Wastewater recycling project	SbT 1, 3, 4, 5, 8, 9
Water pump installation project	SbT 1, 2, 5, 8, 9
Family orchard project	SbT 1, 8, 9
Vehicle maintenance project	SbT 3, 4, 5, 7, 8, 9
Design and manufacture mold casting toys	SbT 1, 7, 8
Housing electrical and water installations	SbT 2, 3, 4, 5, 8, 9
Mana Kanchu project (ISF Navarra, 2009)	SbT 2, 6, 9
Designing and editing a magazine about the cooperation project	SbT 1

These projects must be solved in groups, followed by an explanation in class, tutorial sessions or/and role-play sessions. The projects also include a number of deliverable intermediate tasks, for which student feedback is very useful from the point of view of formative evaluation and teaching improvement.

This methodology not only allows us to design and develop learning activities to study the main subtopics of the MST/EC learning standards but also develop awareness activities, to achieve education in values and democracy education, for example:

- Collection of medicines, clothing, school equipment, etc.
- Awareness days, showing videos, posters, etc.
- Exchange letters with Sahrawi children in schools.

Technical projects are designed to be developed throughout grades 6-12 and supported by awareness projects. So this methodology also allows the participation of the entire education community in the teaching/learning process and motivates the students to improve school behavior.

The scenario which involves working with cooperation projects provides extra motivation for students during the learning process and enables us to develop the selected learning activities and achievement of the learning objectives.

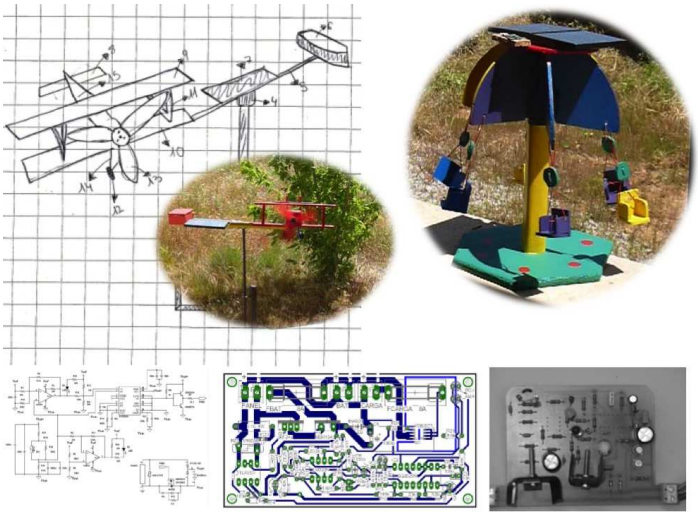

Fig. 1. Learning activities examples.

EVALUATION PROCESS AND RESULTS

This methodology has been used in two different schools during 3 years. These projects have been used with 190 students divided into nine different teaching groups with an average of 21 students, from grades 6 to 12.

We taught these learning activities actively and collaboratively so that the students could achieve the objectives and develop associated capacities. Once each project was finished, we asked the students to fill out an anonymous survey in order to evaluate the usefulness of the activity and to accumulate data for the evaluation of the methodology. We have used the evaluation methodology developed by the teaching-quality research group "GIDOUZ" (Escalona & Loscertales, 2007).

We have evaluated three different levels: The perception of students, academic results, and the full evaluation of the methodology involving the entire education community.

An average of 189 students took part in the surveys, in which they had to assess a series of statements on a scale from 1 to 5 where: 1 represented total disagreement, 2 disagreement, 3 neutral, 4 agreement and 5 complete agreement.

The used questionnaires are different according to the project and the grade, but Table 2 shows the main questions of a typical questionnaire, and Fig. 2 shows the average results of the questionnaire analysis.

Table 2. Typical survey questionnaire.

Q1	The proper use of technology can make a better world
Q2	Working with the cooperation project provides me extra motivation
Q3	The contents studied in this project are useful for my training as an engineer
Q4	Work group has been beneficial to me
Q5	Knowing the social issues surrounding the problem has helped me to better understand technical aspects and the purpose of the project.
Q6	The complementary material provided with the project has been useful for improving my learning.

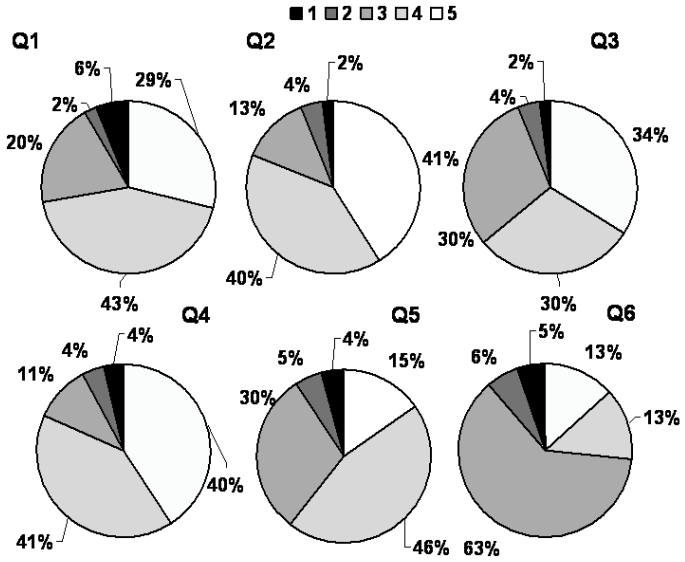

Fig. 2. Project survey questionnaire average results.

Of the total of 189 average students who took part in the survey, almost 75% thought that the proper use of technology could make a better world, while fewer than 8% thought the opposite. Looking at the results of question Q2, it is significant that 81% of students thought that working with cooperation projects provide themselves extra motivation, while barely 6% did not agree. With respect to the usefulness of contents studied, the replies to statements Q3 showed that about 64% of students were in agreement or complete agreement that are useful for their training as an engineer. Only 7,5% thought that group work has not been beneficial. The results of question Q5 show that almost 60% of the students thought that to be involved in the social issues surrounding the problem help them to understand technical aspects and the purpose of the project. Finally, 26% found the additional material accompanying the project useful, while 11% did not find it useful.

The evaluation of the academic results (examinations, presentations, interviews, portfolios, observation of student responses, performance testing, etc) shows a clear improvement over previous years where classic methodologies were used. The number of students passing has increased from 67% to 85%, and the good grades (A or B) had increased from 11% to 35%.

The full evaluation of the methodology proposed has involved the entire education community. At the end of the academic year an evaluation session with the school management, teachers, fathers, mothers and students was held with very positive results. 98% of the participants felt involved in the cooperation project and believed that this methodology had improved the results, motivation and participation of students.

DISCUSSION

After the work is done, one of the questions that arise is “What is the best way to involve students and achieve the best results, not only academicals but also in values: project method learning or traditional method?”.

Traditional learning method is based in the lessons explained by a teacher in a classroom, using blackboard, books and so on, and alternating them with the realization of exercises and test. Doesn´t matter if the students are “bad” or “good”, the risk of boring is very high and even in the case they achieve the desired results, practice is so poor and it is not easy include some values in explanations.

Opposite, we can say that project method learning is based in two principles: experimentation and discovery. It is known that students use to understand and remember all those concepts acquired by experience. Implications of students in making the project are very high usually and with a few theoretical explanations, all the knowledge is getting by doing, learning in most cases, more than with traditional methods. Even more, if the project includes some values, it causes a depth impact in students and makes to ask themselves some questions and sometimes change their future behavior.

So, an adequate mixture of both methods will give us, without any doubt, the best results both academicals and values, but a good training of teachers will be essential to adapt their practice to new generations.

CONCLUSIONS

A curriculum is a framework that sets forth the program's philosophy, goals, and objectives, as well as guidelines for teaching that address all aspects of the student development. The methodology and the guidelines for teaching are just as important as the proposed contents. In engineering studies traditional education strategies inadequately prepare students to engage in collaborative partnerships, promote passive learning and not prepare students for the innovative and flexible role.

An effective program has to promote collaborative learning, project based learning and problem based learning including active initiatives and learning activities. The work in cooperation and socially responsible projects motivates the students to improve school behavior, but also allows the participation of the entire education community in the teaching/learning process. The methodology based in activities related to cooperation projects allows the students feel very involved, improving the academic results, participation and improving the education in values of the entire education community.

The figures show that the experience make most of students think that the proper use of technology could make a better world and encourage them to be involved in social causes. Moreover, one of the main problems with students in "developed" world is the lack of motivation and this methodology results to be a motivation for pupils.

Comparing with the results obtained using classic methodologies, the number of students passing has increased from 67% to 85%, and the good grades (A or B) had increased from 11% to 35%. Also the entire school community valuates the experience as very positive.

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