Problem Based Learning PBL as a strategy for Knowledge Building (KB) based on informatics technology

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Abstract

Knowledge Building places the students in the trajectory of the creativity disciplined and mature of the producer of the knowledge, the creativity of the researcher because the students must work with others in team and investigate from questions. The obtained learning not only depends on the individual efforts but the collaboration of the group. With KB it is possible to approach projects that incorporate characteristics of the work of the adults with contents of the real world and which they use supported sources of information varied specially with use of information technology. The PBL has as objective to engage the students in concepts and central principles of a discipline and it does not have to be peripheral to the curriculum. This objective is better obtained using the tool Knowledge Forum (KF) following the KB principles using (KF).

PBL makes use evaluations based on the performance considering an wide rank of abilities and knowledge. The investigation was made in the matter Select Subjects of Physics I for fifth semester of high school. It was decided to make a project throughout the fourth month period that allowed to incorporate the greater amount of subjects and

concepts for its accomplishment with the methodology of the PBL being handled the principles of KB using KF.

INTRODUCTION

The Modern school needs to work creatively with knowledge that leads to true innovation and knowledge that society demands, because it translates to progress. That is why students must be placed in a development trajectory that goes from the natural inquisitiveness of the young child to the disciplined creativity and maturity of the knowledge creator, the researcher's creativity, and that is the trajectory of Knowledge Building (KB). (Scardamalia and Bereiter, 2002). Knowledge, following the principles of KB, differs from the traditional knowledge in various ways: instead of learning individually with tasks and short and specific subjects, students have to work with others in teams and research based on questions. The knowledge gained depends not only on individual effort, it depends on the collaboration of the team; instead of learning from well-defined lectures, students have to face uncertainty and often have to determine their own ways of appreciating their progress (Chow and Law, 2006).

In an education context, KB means engage the students in a process full of knowledge creation from an early age. Recognizing the fact that knowledge is constructed socially, it is possible to engage in projects that include adult team's characteristics, like those in the real world, as well as using information sources specially supported on information technology. It is important to observe during the project that it doesn't turn into "superficial constructivism"; it is needed that students, in a knowledge

construction process get involved directly in Knowledge Building (Scardamalia and Bereiter, 2002).

History of Project Based Learning PBL

The creation of projects is an ancient tradition in many schools in America and the World. More than 100 years ago, famous educators like John Dewey have reported the benefits that experimental knowledge brings, in which students get directly involved in their learning process.

The creation of the learning/teaching method called “project based learning” is the result of two important developments in the last 25 years: first, the revolution in knowledge theories. Research in neuroscience and psychology have extended cognitive knowledge models and conduct knowledge models to prove that knowledge, thought, action and context are interconnected. Knowledge is a big part of social activity, and it is immersed in culture, community and past experiences. Second, shaping students in order for them to be capable of carrying themselves in a collaboration and social interaction context makes the knowledge necessary to solve situations constantly evolved. This supposes a big challenge for actual education (Alvarez, Ayuste, Gros, Guerra and Romañá, 2005). In this sense, the need for education to adapt to a changing world is the main reason why PBL is becoming a popular methodology in almost the whole world (Slavin, 1990).

PBL's Goal

PBL has as a main goal to involve students in central principles and concepts of a discipline, and that should not be peripheral to the curriculum. With this PBL approach, students, through the curriculum, ask questions or real problems that create the need to know the material, the content. The questions asked are linked to the content of the curriculum, and so, the evaluation is designed to consider the knowledge of content and project results (Ovejero, 1989).

Nowadays, essential tools and abilities such as knowledge technology, self management and project management are needed to handle PBL in a scholar course.

The software and computer used should favor the interaction process and the joint problem solving. Scardamalia and Bereiter (2002) have developed a theory about collaborative knowledge construction, and the appropriate technologic tool called Knowledge Forum (KF). These authors have driven numerous researches about knowledge communities that can come up in school.

Requirements and Characteristics for a good PBL

Collaborative knowledge is used in complex knowledge areas in which planning, task categorization and task distribution is needed. Collaborative knowledge is meaningful when different actions and decisions are present during the resolution of a complex activity. (Álvarez et al, 2005).

To handle PBL in a scholar course, it is necessary to specify products that solve problems, explain dilemmas or present information

generated from research, exploring or reasoning. A project along a course includes multiple products that allow the constant feedback and consistent opportunities for students to learn from their experience. To know the progress from students and to give them effective feedback, the teacher needs to make use of evaluations based on performance, that presents challenges and that requires a wide range of abilities and knowledge (Ferreiro, 2006).

PBL has important benefits for students today because:

- Overcomes the dichotomy between knowledge and thought helping students to “know” and “do”.
- Helps students to learn and practice problem solving, communication and self-handling abilities.
- Integrates curricular areas, theme instruction and community matters.
- Values performance in content and ability using criteria similar to that used in the real world work force, and encourages responsibility, goal gain and improvement in performance.
- Responds to the student needs with a wide level variety in ability and knowledge styles.
- Motivates and reels in bored and nonchalant students.

PBL allows focus on central ideas and outstanding themes within a curriculum, creates challenging activities in the class room and supports self-directed knowledge between students (Jonson, 1987).

PBL with technologic support

The technologic tool Knowledge Forum (KF) was developed with the purpose of working with the highest possible fidelity that can be learned from the work world; it is a tool that favors the development of the aspects needed to engage successfully in the real world. It is about learning to share work responsibilities and distribute them among the team members (Scardamalia, 2002). Its goal is also to favor the knowledge building exploring the relationships between different contributions from the participants. In sum, this tool is a support that helps build a pedagogy based on collaborative construction of knowledge, its focused on committing students in problem solving in a collaborative way, so that the responsibility of success is shared among the students and the teacher. The theory about knowledge construction establishes that ideas, theories and hypothesis are considered conceptual artifacts or cultural artifacts that constitute objects of research that can be debated, improved an applied in different contexts (Álvarez, et al, 2005).

Coverage versus non-coverage

It is true that a project by itself does not cover a long list of topics like the ones that can be covered in a traditional course in a typical class room. With the project method students can learn the same essential concepts but in a deeper way that just reading and discussion bring. Teachers have more time to work with their students once the project has begun. If the teacher is pressured due to time and needs to include many themes in his or her course through out the year, the teacher have to make a decision about the topics that he or she wants to teach in a deeper sense than those that can just be covered. It is

needed to determine which parts of the curriculum can be easy and successfully managed through readings or text book homework and what themes reflect the concept and ideas that are more important in the curriculum and need a deeper explanation to incorporate them in the projects (Ferreiro, 2006).

Research Context

The research was done in the Instituto Oriente de Puebla high school, incorporated to the Secretaría de Educación Pública Federal. In the last year of high school propedeutic areas are imparted as preparation for college. The physics and math area contemplates the subject Select Physics Themes I (TSFI) for fifth semester, and Select Physics Themes II for sixth semester. The program for fifth semester considers some topics viewed on previous semesters that should be treated in a deeper sense and allows the integration of other themes that the institution and the teacher consider necessary according to the group and team's profiles, as well as the academic offer from regional Universities. The program strongly suggests fundamental themes like hydraulics, electricity, magnetism, heat and concepts like Archimedes principle, theory of gas, electrostatics, basic circuits, and magnetic principles among others.

The TSFI student group was formed by 56 students, 8 women and 48 men with an age range from 17 to 19 years old. The program indicates 3 class hours per week, there were held 2 continuous hours on Tuesdays and one hour on Fridays.

Previous Ideas

The previous experiences from the docent in the use of KF and in the teaching of the TSFI class suggest two things: the first, a need of a technologic support for class work as well as the commitment from students to work outside school hours. This is why the course was designed in a mixed mode; it was a blended course, and second, due to the fact that Physics is a subject that tends to be somewhat hard for some students and that they find the subjects hard to connect between each other (for example, they don't see any connection between Archimedes principle and Ampere's Law), it was accorded to make a project along the firs semester that allows the integration of several concepts and subjects in order to make the project successful.

Goals

The initial goals for this experience were:

- Guide the students towards collaborative knowledge construction in a learning environment supported by the KF program.
- Make a project throughout the semester that demanded a deeper comprehension of physics concepts and principles motivated by their application need.
- Favor a meta-cognitive process in which the development of critical thought abilities, understood as the development of awareness of how knowledge is built through the making of a project in students.

Course Description

The methodology that would be used during the course was explained to the students from the very first beginning as well as the purpose of Select Topics of Physics I. It consists in doing a deeper analysis of some topics showed in previous courses of Physics, trying to deal with aspects that are relevant to everyday life, taking into account real problems that allow discussion and reinforcement of knowledge previously acquired, in a way that reasoning through analysis and complex problems solving using basis which can be exercised. This is how we can prepare students to get into college and higher level studies.

The course's objectives were established: Analyzing some aspects of physics from the solving of real problems using theories and science law studies and their practical application, which would allow a better understanding of their impact on everyday life, the industry, the environment, science and technology. To achieve these goals it is necessary to remember and understand certain knowledge from previous courses to define strategies and establish authentic solutions to solve real problems like kinematics'' fundaments, dynamics, electromagnetism and mechanical waves, scientific notation, unit conversions (English system to International system), types of movement, Newton's Laws and electricity.

The project consisted of designing a device to take an aerial photography from the scholastic building at 60 meters of height.

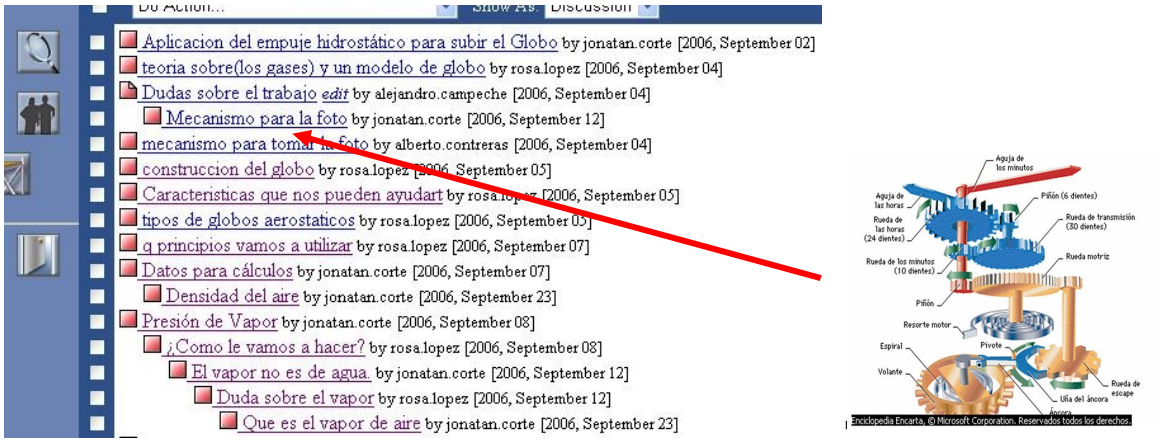
Starting from the project's proposal, the students had to discuss possibilities and find a solution, later developing a fundamental analysis on the theories of physics and mathematics, they had to demonstrate their solution's efficiency and make a model, simulation or practical process of that solution. The activities that the students realized in order to develop their solution's proposal where among others:

- Bibliographical reading.
- Note writing.
- Problem solving of the topics discussed in the proposal
- Report writing of the stages of analysis and solution of the problem or project..
- Alternative demonstration chosen and its explanation.
- Team discussion about the possible solutions, options and limitations of the proposals.
- Glossary writing of the terms and concepts involved in the proposal.
- Elaboration of a technical memory and/or process report from the establishment of the problem to the conclusion including observations about the theory conception and practical process.

It was explained on this course that cooperative learning should be a priority, based on projects focused on student learning, being the main goal to help students acquire knowledge and basic abilities, learn to solve complex real problems and carry out cooperative work using these abilities and knowledge.

It was emphasized the making of projects focused on the solving of complex problems in which the students hold a stronger independence, stronger than that of a traditional class where they can move and use different resources (preferably inside the classroom and lab).

It was explained to the students that the evaluation would take into account both, collective and individual work which through a rubric the criteria was established.



Looking for mechanism to take the picture

Project Following:

The teams made different solution proposals that can be summed up into three different types:

- Helium balloons
- Hot Air balloons
- Projectiles

One of the teams presented the option of elevating the photographic camera through two helium-inflated balloons. They proceeded this way:

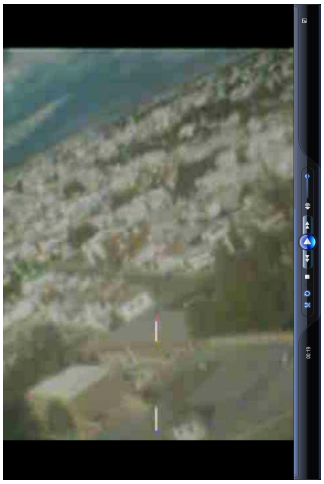
Discussing about ballons

Measured the necessary volume of the two balloons, their design included a valve that through a delay mechanism let out some helium so the camera could descend after taking the picture.

The hot air balloon option was taken by several teams that studied the balloon-making techniques; the geometry needed for a good performance and presented different delay options for the camera clicking. There were electronic and electromechanical proposals. The electronic was based primarily on the Timer 555, which allowed the students to learn electronic principles and dome types of integrated circuits like the multi-vibrators.

The third type of idea for making this project consisted on launching a wireless video-camera as part of a projectile whose propulsion was pressurized air. As the camera descend due to gravity, and the projectile's design was facing down, the images were registered on the computer. The camera descended slowly on a parachute. This idea seems to us as the most original for the making of this project, the students built their bazooka, their projectile, their parachute and their opening mechanism.

Photography taken from balloons inflated with helium



Photographies taken from projectiles

The evaluation of the academic achievements of the period considers the building of knowledge through aspects such as the progressive improvement of source searching, the notes classification and the notes compilation at the group discussion that showed the level of cooperation among students and was reflected on the project itself, the topic exposition and the written evaluations.

Conclusions and Results

The PBL managed from the KF is a very pertinent methodology in the high school context that incorporates the best methodologies to support the new ways of learning because it allows work inside and outside the classroom from a cooperative learning perspective. Besides, it offers the possibility of e a continuous evaluation where student feedback towards the teacher is constant. It is important to emphasize the motivation potential of this methodological proposal because it sets the students in a situation to perform as professionals. They do work that, as Scardamalia (2002) points out, engage them directly in an investigative process in which they develop collectively their creativity, responsibility and built knowledge cooperatively.

By the obtained results it can be said that the PBL with KF is an excellent way of deeply developing the student's abilities and that it should be considered for future courses in other disciplines.

The students have the best appreciation of this experience's results. Here are some of their conclusions:

This project was a great challenge for everyone because we learned, reasoned and thought in a way that was not done before…working as a team helped us a lot because of brain storming from the five of us. The KF helped us a lot… we feel proud of completing this experiment pleasantly.

Team 1

…..we did the checking of all formulas and real life applications and it is one of the best ways to learn something for what it is, and also creating something with our own hands and making the device are things that make this projects worthwhile.

Team 6

When you work experimentally, problems appear an option, alternatives…that's when you learn the best, because you have the need to investigate, discuss and study the different ways to solve the problems that emerge during the process of finding the best solution for the main goal. The KF was very useful for this…

Team 9

…. This project that has brought us very close (and for the first time) to the solution of a real problem…not only did we focus on the Arquimides' principle (main principle on the balloon's construction) but we also worried for other factors like steam pressure, combustibles, volume…besides putting in practice knowledge previously acquired, we acquired new knowledge (use of transistors, RC circuits)…

Team 10

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