Aprendizaje basado en problemas para la enseñanza de los PLC en la Universidad Tecnológica de Altamira

Learning based on the problems for the teaching of the PLC at the Technological University of Altamira

Aprendizado baseado em problemas para ensino de PLCs na Universidade Tecnológica de Altamira

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Resumen

El Aprendizaje Basado en Problemas (ABP) es un método de enseñanza-aprendizaje centrado en el estudiante en el que éste adquiere conocimientos, habilidades y actitudes a través de situaciones de la vida real. En la Universidad Tecnológica de Altamira al ser parte de instituciones de educación superior tecnológica en México, incluye en sus programas de estudio el manejo de los controladores lógicos programables (PLC), lo cual constituye parte de su formación como mecatrónicos en la implementación de sistemas automatizados con aplicación industrial. La presente investigaciones propone el uso del método ABP para el aprendizaje de los PLC´s, mostrando los resultados que relacionan el desempeño académico de los alumnos de los grupos de experimentación.

Abstract

Problem Based Learning (PBL) is a student-centered teaching-learning method in which students acquire knowledge, skills and attitudes through real-life situations. At the Technological University of Altamira, which is part of the higher technological education in Mexico, includes in its programs the management of programmable logic controllers (PLC), which is part of his training as mechatronics in the implementation of automated systems with industrial application. The present research proposes the use of the ABP method for the learning of the PLCs, showing the results that relate the academic performance of the students of the experimental groups.

Resumo

Aprendizado com base em problemas (PBL) é um método de ensino-aprendizagem centrado no aluno no qual o aluno adquire conhecimentos, habilidades e atitudes através de situações da vida real. Na Universidade Tecnológica de Altamira para fazer parte de instituições de ensino superior tecnológico no México, inclui em seus programas de estudo o gerenciamento de controladores lógicos programáveis (PLC), que faz parte de sua formação como mecatrônica na implementação de sistemas automatizados com aplicação industrial. A presente pesquisa propõe o uso do método ABP para a aprendizagem do PLC, mostrando os resultados que relacionam o desempenho acadêmico dos alunos dos grupos experimentais.

Introduction

Programmable logic controllers are solid state members of the computer family, which use integrated circuits instead of electromechanical devices to implement control functions, are capable of storing instructions, such as sequences, times, counts, data manipulation and communication for control machines and industrial processes (Bryan, 1997).

 In problem-based learning, the student is expected to build their knowledge on the basis of real-life problems and situations, presenting the problem and then identifying the learning needs, searching for necessary information and finally returning to the problem. The Technological University of Altamira (UTA), as part of the institutions of higher technological education in Mexico, offers careers whose study programs include PLC management.

PLC expository classes today become monotonous for a system such as technological universities, it is evident the need for change in the conception of the teaching-learning process without this means that the lectures are deficient. The teachers of this institution realize the need to rethink the way of teaching so that students meet the demands of professional practice, starting from a pedagogical point of view, the question that guides this research is:

How does the PBL intervene in the academic achievement of the students of Mecatronica in the UTA?

This research poses a problem for students with PLC, where they can understand and build their own knowledge about a real life problem, presented the problem and identifying the need that leads them to learning solutions in a practical industrial automation, with the purpose of making a comparison between two groups: one of them using the ABP method and the other working in the traditional way. Finally, the results obtained in these relationships are evaluated in the academic performance of the students.

Theoretical fundament

The origins of problem-based learning go back to the 60's and 70's where a group of medical educators from the University of McMaster recognized the need to rethink its contents as a form of medical education, being evident that the profile of its graduates required skills in solving problems, including acquiring information, synthesizing it in possible hypotheses and testing them through the acquisition of additional information, this was called deductive hypothetical reasoning (Morales and Landa, 2004).

On hypothetical deductive reasoning, the Faculty of Health Sciences of the University of McMaster in Canada established a new medical school, with an innovative educational proposal that was implemented throughout the three years of its curricular plan and is known currently throughout the world as Problem Based Learning (Barrows, 1996).

There have been changes in several aspects of our life: communication through electronic means, access to information and technology, are clear examples. Our students must prepare themselves to join the productive sector, times are very different from those that existed twenty years ago. The problems that these future professionals face demand innovative approaches and problem-solving skills.

The PBL supports a relationship between meaningful learning and experience that translates into how students learn, using problem solving and reflecting on their experiences. In this sense, the PBL has a double emphasis; On the one hand, help students develop strategies and build knowledge (Homo, Ferrari, 1997, Kolodner et al., 1996), and on the other, support them in their ability to be active learners and students responsible for their learning (Duch et al., 2001). in their capacity to be active learners and students responsible for their learning (Duch et al., 2001).

The ABP is a methodology that allows the development of certain competences fundamentally linked to the resolution of complex problems, since it provides students with opportunities to reflect on the facts that cause a problem, forcing them to investigate to understand it and try to

solve it, achieving thus enhance their reasoning ability and cognitive flexibility (Hmelo; Guzdial, 1996).

The cognitive levels of compression identify characteristics in university graduate students such as: capacity for teamwork, high level of communication, management of technologies and simulation software, better understanding in the English language, search for information that allows the student to apply the knowledge when required, ability to reach decisions and conclusions supported which translates into solving problems.

According to (Glaser, 1991) three principles related to learning and cognitive processes can be clearly established: learning is a constructive and non-receptive process, the cognitive process called metacognition affects the use of knowledge, and social and contextual factors they have an influence on learning.

Learning is a constructive and not receptive process

Knowledge is structured in networks of related concepts, called semantic networks. When learning occurs, new information is coupled with existing networks. Depending on the way this process is carried out, the new information can be recovered with less effort and used to solve problems, recognize situations or effectively save knowledge.

Semantic networks are not only a way of storing information, they also have an influence on how they are interpreted and memorized. For example, when a new text is read, certain passages will activate the networks that contain the existing knowledge necessary to build and retain the meaning of the new text. If this does not happen, reading comprehension is inhibited (Gijselaers, 1996).

Metacognition affects learning

This second principle indicates that learning is faster when students possess skills for self-monitoring, that is, for metacognition. Metacognition is seen as an essential element of expert learning: setting goals (What am I going to do?), Selecting strategies (How do I do it?) And evaluating achievements (did it work?). Successful problem solving depends not only on the possession of knowledge, but also on the use of resolution methods to achieve goals. Good students detect when they understand a text and know when to use alternative strategies to understand the learning materials.

Brunnig et al. (1995) propose several teaching strategies that are useful for developing metacognition: motivate students to become deeply involved in the process; focus on understanding instead of superficial memorization; promote the development of new ideas; help the students to ask themselves questions that can be answered during the resolution of the problem.

Social and contextual factors have an influence on learning

Social factors also influence the learning of the individual. Glaser (1991) points out that in working in small groups, the apprentice's exposure to alternative points of view is a great challenge to start understanding. By working in groups, students expose their problem-solving methods and their knowledge of concepts, express their ideas and share responsibilities in the handling of problematic situations. By being in contact with different points of view about a problem, students feel encouraged to ask new questions.

For Vigotsky (Álvarez y Del Río, 2000), learning is a social activity, which results from the confluence of social factors, such as communicative interaction with peers and adults (in age and experience), shared in a historical moment and with particular cultural determinants. For him, learning is more effective when the apprentice exchanges ideas with his colleagues and when everyone collaborates or contributes something to arrive at the solution of a problem. In this perspective, one of the fundamental roles of the teacher is to encourage dialogue among his students and act as a mediator and as an enhancer of learning.

The effort to generate learning environments where students are the articulating axes of rhythm and quality, is presented as a challenge for the current university teaching, which, combined with the need to articulate the training itineraries in competencies, implies rethinking methodological strategies and resources used to achieve the deployment of proactive teaching methods (Mora, 2004).

Barrel (1999) points out some reasons, based on research, that support the importance of PBL:

The processing of information at higher levels, such as in the resolution of problematic situations, critical thinking, strategies of inquiry and reflection on practice lead to deeper understanding (Perkins et al., 1990); self-direction (McCombs, 1991), and superior retention and transfer of information and concepts (Bransford et al., 1986; Mayer, 1983).

- Learning is greater when people use information in a meaningful way (Marzano, 1997).
- Three central goals of education are retention; the compression and use or application of information, concepts, ideas, principles and skills (Perkins et al., 1990).
- In controlled experiments, students who use PBL in class showed a significant increase in the use of problem solving strategies and getting as much information, and many times more, than students in traditional classes (Stepien, 1993).

Methodology

It was proposed to use a problem using PLC to understand the concept of automation, DiFrank (2007) "defines the term automation as automatic operations performed by an apparatus, process or system that are controlled by mechanical or electronic elements that act as the organs of the human being". Automation is the basis of disciplines in areas such as: pneumatics, hydraulics, instrumentation, automation and process control whose industrial applications are important for the daily life of students and society in general.

The route that the student follows during the development of the ABP process can be synthesized according to Morales and Landa et al., (2004) in the following: Read and analyze the problem scenario, brainstorm, make a list of what it is known, create an inventory of what is unknown,

organize a memory of what needs to be done to solve the problem, plan research strategies, define the problem, obtain information and present results.

The first step was to examine what characteristics the problem-based learning method should have applied in a difficulty to specifically provoke the understanding of concepts in the students' academic performance; the problem is proposed in order to analyze it, understand it and situate itself in the scenario of the discussion within a work team.

Carry out the automation of a multi-use cell, taking into account that when detecting the presence of some material, the process will begin to work in the following way: direct the starting object to the final part of the vertical piston, activate the output of the horizontal cylinder By ejecting the piece, the vertical piston returns to its retracted stem state and when the object falls the sensor contained in the indexing table will make a turn. At that point the process ends and it will start again when a piece is placed again. In Figure 1 the complete step of the multiple use cell is exemplified.

Figure 1. Celda de usos múltiples laboratorio de Mecatrónica.
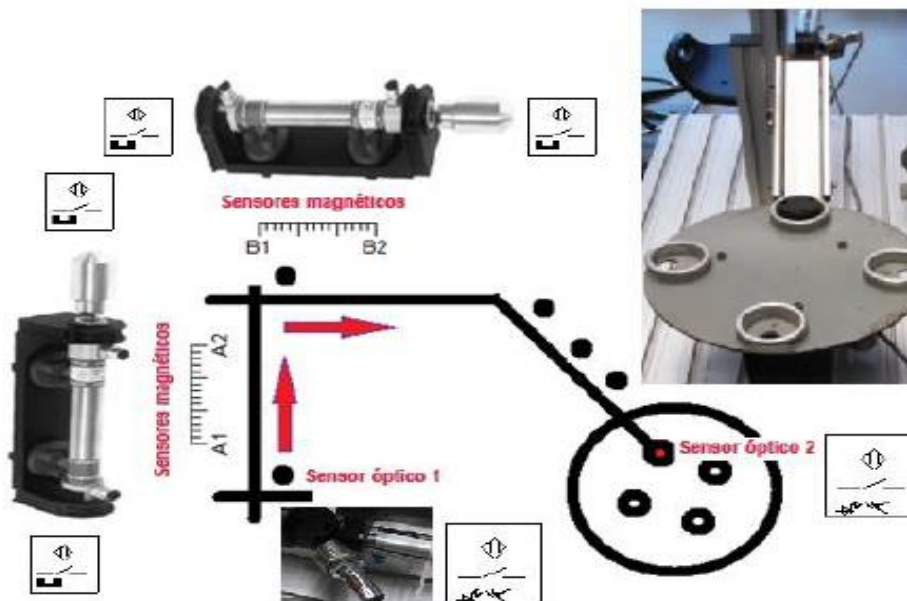
Source: elaboración propia.

We worked with the opinions of the students through a brainstorm explaining the theories or hypotheses about the causes of the problem, the way how to solve it. These were written in your notebook to be accepted or rejected, some of them were in the form of questions: How is the automation of the process carried out? How many sensors intervene? What are the elements that are used as input or output in the process? Why do the sequence requested and not look for another alternative?

From the generation of questions, we worked with a list of what was known and unknown about the process, what the team believed it should be known to solve the problem. There are several types of questions that could be appropriate; some related to concepts or principles that should be studied to resolve the situation.

It was proposed to write a document with what was needed to solve the problem effectively through research strategies, in this way they clearly defined the problem, explaining in detail what they wanted to solve, producing, responding and testing the solution in order to present results for the preparation of a report where recommendations of the experiences obtained are indicated.

During the delivery of the subject of PLC, two groups of students were selected, one that received the classes in a traditional way and the other was treated through the ABP teaching method. A group consists of 23 students and the second group is formed by 27 students, who were examined to measure their degree of assimilation in the PBL.

The time that was provided to solve the problem was a two-hour class, based on previous knowledge in class, a practical demonstration of the subject was also required in the laboratory with students of the third quarter of the Mechatronics career, in this way the knowledge it is amalgamated because the students bring the ideas of the classroom and check them in a kinesthetic way with the test equipment.

The indications for this test are as follows: students must use their knowledge of programmable logic controllers to make the required connection, reaching to understand the concepts of the problem, automation, connection of magnetic sensors, connection of optical sensors,

identification of input elements, output elements, vertical double-acting piston, indexing rock, relay modules, 24-volt power supply and use of the Zelio relay. Figure 2 shows the proposed diagram for finding a solution to the problem.

The assessment instruments were applied to the two groups just after viewing the class contents and the results were measured; finding favorable effects of learning, what served to measure the progress of achievement of students in the third quarter of the career of Mechatronics.

Figure 2. Diagrama propuesto para la búsqueda de solución al problema.
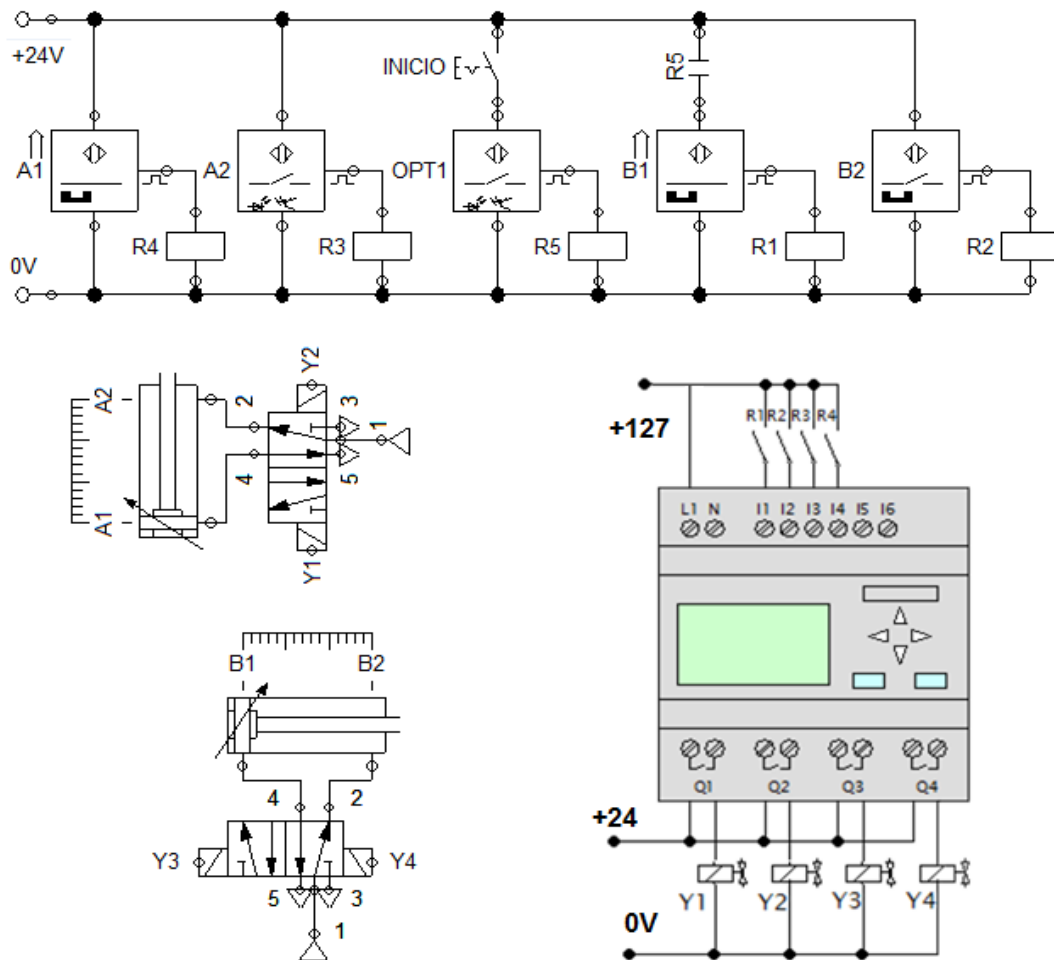
Source: elaboración propia.

Discussion

One of the strengths of the problem-based learning method is that it allowed students to question many things about the proposed problem, better understanding the situation to be solved, learning to work in a team, fostering the habit of thinking, discerning between what is useful and what is not. in order to improve the process and generate less expenses in the implementation, motivating them in their abilities to invent and apply their experience in future situations.

It was observed in the research the integration of students who generally showed apathy, they were very motivated and involved, they even proposed possible solutions to the problem, their teammates who previously ignored them expressed cooperation with them taking into account their opinions, reaffirming with the Brainstorm the knowledge and learning acquired in the classroom.

The restrictions that were presented were the refusal with some professors in the support of the research, due to this work was done with two established groups, this situation was generated because the teachers do not work with the subject of programmable logic controllers; another limitation was in terms of the time of application of the research that was evaluated only to students of one generation during a school period.

Conclusions

The use of PBL at the Technological University of Altamira revealed an advance in the academic achievement of students, as can be seen in the data expressed in Table 1, their learning showed progress in each of the published indicators of the groups: traditional and application of the ABP. It is concluded that in the first test applied with the traditional method there is no motivation, students work individually without sharing their experiences with the rest of the team, this is a situation that is sought to correct with the application of PBL, the results obtained in method A were in understanding theoretical concepts 50 and understanding practical concepts 59.

Table 1. Indicador de desempeño académico primer examen.

Indicador de desempeño académico primer exámen		
Grupo	**Comprensión de conceptos teóricos**	**Comprensión de conceptos prácticos**
A (método tradicional)	50	59
B (método ABP)	85	87

Fuente: elaboración propia.

The data seen in Table 1 method B applying problem-based learning led students to use skills in problem solving, interesting students in the search for information that would support the practical solution of where they wanted to go, adjusting their needs to understand ideas; the results obtained were in understanding theoretical concepts 85 and understanding practical concepts 87.

In Table 2 column 1 in relation to theoretical concepts with practical, the performance of both groups remained good but the result was still optimized in method B; in column 2 method A does not apply and in B it was quite favorable since the students got used to working with PBL effectively, the results obtained were in column 1; relation of theoretical concepts with practical method To its evaluation throws 80, in the method B column 1 improved the qualification and in the understanding of method ABP the result thrown was of 92.

Table 2. Indicador de desempeño académico segundo examen.

Indicador de desempeño académico segundo exámen		
Grupo	**Relación de conceptos teóricos con prácticos**	**Comprensión del método ABP**
A (método tradicional)	80	**No aplica**
B (método propuesto)	87	92

Fuente: elaboración propia.

The results of the investigation showed an improvement in each of the indicators, therefore the use of the ABP method is concluded to be a success.

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