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Cooperative learning in the implementation of teaching chemistry (didactic instrumentation) in engineering in México

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Abstract

In engineering you think of chemistry as a difficult and boring subject. Some professors who are teaching it, have seen apathy and lack of interest in the students. This paper presents some findings of an investigation done which allowed to listen to the voice of 250 Mexican students regarding the usefulness of cooperative learning in chemistry. An exploratory-descriptive methodology was applied, together with a pretest and a post-test. By implementing the Cooperative Learning, the importance of the positive interdependence for critical thinking was appraised and a move away was detected from the theoretical content and meaning of the everyday context of the students.

Peer-review under responsibility of the Sakarya University

Keywords: Cooperative learning, didactic instrumentation, engineering

1. Introduction

The speeches related to educative competence are often oriented to promote and impulse the student to an integral development as a process that goes beyond transmitting knowledge and skills. For this reason, the need to fulfill the application of knowledge, skills and attitudes which are expressed through the Know, the Know-How and the Knowing Self is pointed out (Delors, 1996).

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Higher technological education under the competency-based model must conform to the constant changes taking place in today's world. It pretends to be an integral approach, which seeks to bond the educative sector with the productive one to form competent professionals who contribute to the technological development.

In Polytechnic Universities (UUPP), classes are taught with this model of competency-based education. As a consequence, needs and challenges have been observed in the daily development of the teaching and learning process that requires research in order to improve them. The high scholar failure rate is one of the challenges found in the subjects of the first semester of engineering particularly in the subject of Chemistry.

2. Problem Statement

Several educational programs of the UUPP integrate in their curricula planification subjects related to chemistry. Such is the case of the following engineering: Mechanical Automotor, Biotechnology, Biomedical, Physical Therapy, among others.

Learning this science develops in the student the ability to analyze quantitative and qualitative processes to understand and control the composition of the elements, the compounds and the solutions of the body. Besides, chemistry is a cornerstone on which other scientific disciplines are based such as biology, physics, genetic engineering, pharmacy, medicine, electronics, geology, oceanography and agronomy. Therefore, it is found in all fields of the applied science which marks the scientific and technological development.

It is clear that many areas are related to chemistry. For this reason, it is important to consider it in the curricula of engineering, so the students can become aware of the relationship that chemistry has with other disciplines, and its theoretical and practical application which represents a great challenge in the teaching- learning process.

Traditionally, chemistry has had a bad reputation among the people as a difficult and boring subject. Professors who teach it have noticed that the first reaction of most of the students that come from educative programs not related to chemistry is of annoyance and a complete blocking of communication with the teacher. The identified challenges are related to the withdrawal from the academic issue with the daily life which definitely have caused an indifference in some students who are learning chemistry.

For this reason, the professors must create learning environments that awakens and stimulate the interest of the students in chemistry.

3. Objective

The purpose of this paper is to share the most relevant findings of an educational research that allows access to the opinion of some engineering students from a Polytechnic University, regarding their experience in cooperative learning in chemistry.

4. Conceptual Framework

Regularly chemistry professors are professionals who were trained in an educative program with a bachelor’s degree in chemistry or engineering. They try to apply the most effective teaching and learning process of chemistry. They also lead projects in the science laboratories, and are tutors of some students or curriculum developers. However in most cases, they have their first teaching experience at the university. As a result, they usually have lots of doubts and questions on how to start a class.

With this in mind, it is clear that chemistry professors face challenges to improve their quality of teaching. Therefore, it is important to recognize didactic instrumentation as an organization of a set of ideas and activities that allow the development of an educational process with meaning, significance and continuity (SEP, 2009).

The development of didactic instrumentation involves: analyzing and organizing educational content; determining purposes and intentions, setting and sequencing activities focused towards the achieving of the established objectives. Besides of coordinating these activities in time and space. This means to establish a full comprehensive action plan and have clear educative foundations which guide the entire process. (SEP, 2009).

Cooperative learning (CL) is also another methodological alternative Johnson,(1999) that can break out an educational paradigm which leads to an individualistic work among the students, and increase uneven competences among the young people with different characteristics, common aspects of the traditional education.

Consequently, different challenges are generated. One of them is found in the relationship between the academic themes and the daily life. Even though, this is not the only risk in the process, it must be considered as one of the most determinant causes that leads to visualize the lack of interest in some students to learn chemistry. Therefore, teachers must promote learning environments that awaken and motivate students. Hence, the importance to know the students perceptions regarding the usefulness of implementing cooperative learning in chemistry classes.

5. Research Methodology

In the development of the research, a mixed methodology was employed. In this respect, Hernandez, Fernandez and Baptista (2003:21) affirmed that the mixed designs "represent the highest degree of interaction or combination between the qualitative and quantitative approaches. Both are mixed or combined into the whole research process, or at least in most of its stages". They emphasize that mixed designs allow to obtain the best evidences and understanding of the phenomena. Therefore, the opinions from the students are invaluable for the understanding of the processes taking place inside the classroom.

In this respect, Creswell (2008) states that it is possible to integrate in the same study, quantitative and qualitative methodologies in order to generate more understanding about the subject. In this case the main part of the research was to identify how the students perceive the cooperative learning, its advantages and disadvantages.

The population was of 250 students located in the first semester from different engineering. A pre - test with 22 items to identify the strengths and weaknesses perceived by students in the use of cooperative learning (CL) was applied. After the introduction of the CL, its effect was evaluated by using a post - test with 25 closed answer items and 3 open answer items with a random sample of 84 students. To detect effects from the perception of students about cooperative learning in the classroom, we took notes during the implementation of activities.

In this educational research, first we explored the strategies used to have a base in order to choose the one which will help to realize the intervention. Later, we apply the CL in four groups of chemistry. To close the process we used a second questionnaire for the students who participated in the experience of CL to find out how the university students perceived the cooperative learning, their advantages and disadvantages.

The first questionnaire (Q1) was designed with 22 questions in the Likert scale with four answer options (never, very little, sometimes and frequently). It was applied to a sample of 250 students located in their first period, May-August 2013, to identify the strengths and weaknesses perceived by students regarding the strategies used during class. The validity of this test showed 0.93 on Cronbach's alpha.

6. Results and Discussion

In the first stage of the educational research, the most difficult subjects in first grade were detected as perceived by the students, are shown in the following, see Fig.1.

Table 1 Difficult Subjects

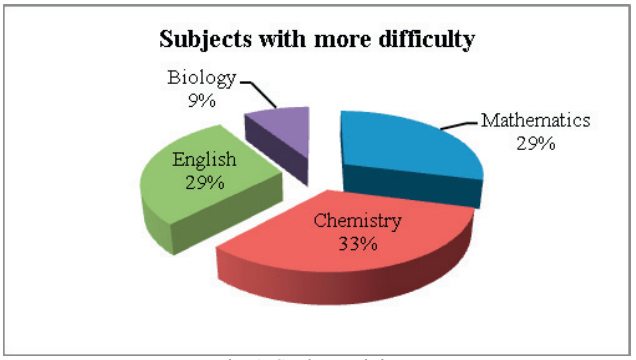

Fig. 1. Student opinions.

In Fig. No. 1; you can see Math, English, Chemistry and Biology, as the most difficult subjects identified by the students.

Similarly the strengths and weaknesses in the didactic instrumentation chemistry was detected, as shown in the following, see Fig. No. 2

Table 2 Didactic Instrumentation in Chemistry

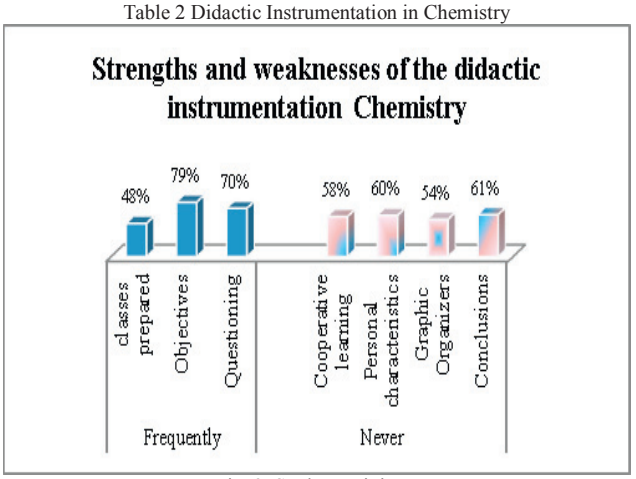

Fig. 2. Student opinions.

Based on the results from the first questionnaire, CL strategy was selected to implement in groups because it was one of the less frequently used, in addition to its potential benefits within the classroom. We consider five basic elements that guided this alternative methodology: positive interdependence, interaction that promotes; individual and group responsibility, social skills training, and a review of group process, from Jhonson (1997) brothers.

It was observed that organic chemistry subject was the most difficult, as perceived from the students; and the second most difficult was the subject of Instrumental Analysis. In a second moment the students identified strengths and weaknesses of the use of CL in their classes;

- In the pretest, we found that 60% of the teachers used mainly the interchange of opinions through questions and answers.
- After using CL, the post-test results showed how relevant students' opinions were, because they were able to: spend more time studying properly; improve their attention; compare ideas to learn more; reduce workload and encourage understanding and reflection from the topics and their practical application in their daily life.

The attendance records showed that both, teachers and students appreciated the advantages of cooperative learning. However, in some situations the difference between the individual, competitive and cooperative work is not clear yet.

In Chart No. 2; you can see from the scale used that 48% confirmed that teachers often prepare carefully their classes, 79% explain the objectives and 70% use the method of questions. On the other hand, it showed that 58% never utilize cooperative learning, 60% do not consider the personal characteristics from students, 61% said they are not able to finish their classes thoroughly, and 54% do not supported their classes using graphic organizers to explain different topics.

Students pointed out several reasons why they fail: lack of the basic knowledge; lack of good habits to study; accelerated dynamic of the courses and overdoses of homework in some subjects.

They also emphasized that one of the main factors for some students is the lack of financial resources in their homes and the lack of interest they perceive in the teaching of a subject.

The students suggested that classes could be more enriched with practical activities to understand the theory easily and mainly focusing them to their area of study and their everyday life. As well as to provide an individual attention in the classroom, a factor that emerged with the CL. They ask to have a more detailed and diversified lesson plan with different strategies, so the contents can be analyzed with more detail.

It was noted that CL facilitates positive interdependence of tasks when planification is detailed and promotes the importance of each student activity to interchange and develop their critical thinking, and enhances attention of the different personal characteristics of students as shown in Figure No. 3

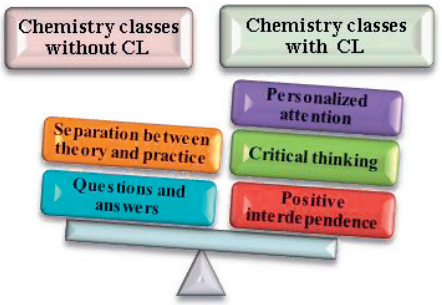

Fig. 3. Student opinions.

Conclusions

The findings in the first phase revealed the didactic instrumentation research from the students studied is in a transition process because there are still methods and techniques, characteristics of the traditional education. It requires awareness in the organization of teaching in the universities which work in models based on competences development. It implies to focus in the development of the construction of student learning, relating it to the logic of the various disciplines in the employment context in which future graduates will be inserted. Traditional team work lacks of individual responsibility, which leads to inequality in terms of work and commitment invested. It is possible to find students doing most of the work while others contribute very little or do nothing. They "lack of equal participation" (Kagan,1994:25).

For that reason, teachers must incorporate different methodological designed options to promote higher-level cognitive processes and processes of creative and critical thinking of the various contents. This is the only way, university teaching can become a significant formative impact on the holistic formation of the student.

Therefore, it is required that teachers should be able to plan and create active learning environments such as CL; and encourage students to acquire and construct knowledge through their study and bonding with their daily life.

This educational research helped to identify strengths and challenges of implementing the CL based on the UPP educative model to establish meaningful scenarios in teaching chemistry model. Students and teachers identified the usefulness of this alternative methodology to promote chemistry subjects of positive interdependence. An aspect that emerges when all group members are aware they cannot succeed unless their classmates are able to reach it too. If they consider the effort made by each student, benefits himself and the others, (Johnson,1994:34).

Positive interdependence allowed that the interchange and coordination of activities move groups to generate critical and controversial issues that help to understand the subjects better and bring on to improve student learning and facilitate the connection between scientific and everyday thought.

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