INFLUENCE OF PEER METHOD AND IBSE ON SCIENCE COMPETENCE ON CHILEAN SECONDARY STUDENTS.

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Abstract

The poor Chilean performance in tests, such as PISA, has evidenced the low level in scientific competences acquired during primary and secondary school. As a consequence of it, new methodologies to empower student in this area are needed. With this as the main goal, our research was based on competence level variations in students from 15 to 17 years old. They were acquired during Physics class in a Chilean school. It was developed using a traditional methodology compared with two active methodologies: Just in time teaching (through Peer Method), and Inquiry Based Science Education. These results were analyzed through diverse statistical tests which compared the variation between a pre-test and a post-test. Our results indicate that the students’s competences level do not always improve using active methodologies in the Chilean classroom. Different factors should be considered in the learning processes. We conclude that for the active methodologies for the chilean case, the students preparation is needed. Expressivity, confidence and team activities will be beneficial for our classroom system.

Keywords

Secondary Education; IBSE; Peer Method; Meaningful learning.

Introduction

The Chilean education experiments a critical time. Even if the international tests shows good results that consider our country as an educational leader in Latin American countries, these are below the average of the rest of the OECD countries. For example, in science the 34% of students are below level two of scientific competences. Moreover, only 1% of them achieved the highest levels (Agencia de Calidad de la Educación, 2013). Thus, the main implication corresponds that, in spite that the students have some science knowledge, they are unable to apply this knowledge outside the classroom (González et al., 2009).

One of the reasons for this poor performance in scientific competences is related with the Chilean traditional education. The
curriculum promotes the contents memorization and the student passiveness (Ahumada, 1998; Cárdenas, 2004). This cause a low interaction between the new information and the student's previous knowledge (Carretero, 2009). In other words, traditional learning is mainly focused in the verbal knowledge "delivered" by the teacher and "copied" by the student, centered in routine and individual tasks, where the student has to memorize and repeat the information in order to take a test (Pozo and Gómez, 2009). Furthermore, teachers tend to assign a greater importance to the conceptual contents over the skill and attitude developments. The Chilean teachers generally keep the curriculum without changes, doing exposition-based classes where they are the focal point (González et al., 2009).

To enhance the students’ scientific competences, was suggested a methodological change to develop the physics class: through Active Methodologies (AM): Just in Time Teaching through Peer Method (PM) and Inquiry Based Science Education (IBSE). These were compared with the traditional method, aiming to verify the effectiveness of each classroom methodologies in regards of the development of scientific competences in our students.

The PM and the IBSE have been widely studied by several authors, so, what then has this proposal to offer?

Our proposal shows some challenges: in Chile, the PM has been studied only at university-level, while the IBSE has been applied just in primary schools. This leaves a gap in the secondary schools, where there are not strategies that promote scientific inquiry or the development of scientific competencies by the chilean students (Gonzalez et al., 2009). These correspond to the main motivation behind this research, to answer the question: are there any significant differences between the use of different methodologies in terms of the development of scientific competence by high school students?

**Methodology**

The *Active Methodologies* (AM) are strategies where the student has the lead role in his own learning process. Thus, the protagonist of the learning process is the apprentice by himself, and the teacher has an accompany, guide, assess and support role for the student, so the student achieves independence and autonomy in his process (Fernández, 2006).

Independent the AM applied, these share some common goals, such as the development of intellectual capacities, communication skills, values and attitudes, supporting personal autonomy, encouraging teamwork and reflective practice, improving student metacognition, acquisition of meaningful learning and the development of interpersonal skills, among others (Luzón et al., 2006; Exley and Dennic, 2007). Also, a greater level of interaction between students helps not only themselves, but it also helps to significantly decrease the gap between men and women in terms of their grades in physics (Lorenzo et al., 2005).

*Just in time teaching (Peer Method)*

*Just in time Teaching* is a collaborative learning technique in which the interaction student-student and student-teacher is
promoted, through the discussion of concepts during class (Mazur and Watkins, 2009).

To develop this strategy, we proceed as follow (Figure 1):

1. First of all, the teacher makes a brief lecture to introduce the concept.
2. Secondly, it shows a multiple-choice question aligned with the concept.
3. Then, the students discuss the questions in pairs and vote using clickers.
4. Finally, and according to the number of correct answers, the teacher has different options to continue:
   • If the correct answers are less than 30%, the teacher has to review the concepts again.
   • If the correct answers ranged from 30% to 70%, the teacher has to promote discussion among different groups of students, who will debate the right option to consider. After that, they have to vote again.
   • If the percentage of correct answers is over 70%, the teacher has to explain the next concept (Crouch and Mazur, 2001).

Figure 1: Peer Method process, adapted from Lasry (Lasry, 2008).

The advantages of this methodology correspond to his effectiveness during the working in big groups of students. Furthermore, it promotes critical thinking, helping to improve and solve problems with their partners (Rao and DiCarlo, 2000), besides, provides the feedback to develop the class properly.

*Inquiry Based Science Education*

The *Inquiry Based Science Education* consists in a group of activities in the laboratory where the students, opposite to the traditional laboratory sessions, have an active role, while the teacher acts like guide, orienting to the student. The student uses the scientific method to learn in different situations (Mora, 2005).
In this research, was implemented the *structured inquiry* (classified by Trnova and Torva, 2011). At this level, the teacher, using research questions, helps the students to develop an explanation for the phenomenon based on evidence obtained experimentally (Trna and Trnova, 2012) (See Figure 2).

This strategy presents many advantages, for example, it allows the students to relate the contents learned in a specific context, develop their innate curiosity, and explore capabilities (Trnova and Trna, 2011; Sánchez and Sierra, 2012). Furthermore, encourages them to discover and rediscover in science, helping to promote scientific attitudes, showing that the scientific problems are not beyond their daily life (Mora, 2005; Castellanos and Zamudio, 2012). These develop the critical thinking, creating a positive attitude toward science (Trnova and Trna, 2011).

![Figure 2: Inquiry Based Science Education](image)

**Implementation in Chile**

*Population and sample*

The sample was constituted by 25 students from second year of secondary school (between 15 and 17 years old) from a private school. The next table shows the characteristic of the population and sample.

| Table 1: Population and sample |
Like the majority of the inquiries in educational fields, this was implemented by a quasi-experimental design, because the groups were pre-established, not randomly selected (Campbell and Stanley, 1995). Two groups participate in this research: an experimental and a control group. In the experimental group was implemented the IBSE methodology, while the lectures were developed by *Just in time teaching* using the *Peer method*. In the control group were implemented the same laboratory activities that in the first group, but after a traditional lecture. This was done during the thermodynamic chapter.

To compare the results obtained, was applied a scientific competences test in each group before and after the intervention, three months later. Our test consists in 23 questions, extracted from the PISA science test.

### Table 2: Experimental Design.

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<th>Treatment</th>
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### Results and analysis

For a better understanding, our results were divided in two sections. The first section shows the results for each group in the pre and post test, while in the second section, is presented the comparison between the experimental group and the control group results.

**Pre Test – Post test analysis**

To analyze the impact of the new methodologies, we compare the difference between pre and post test for each group. In order to identify if our differences are significative statistically, was used the *Wilcoxon’s W* test.

**Experimental group**

The graph 1 shows the results obtained by the experimental group. This group worked with the PM and the IBSE.
Graph 1: Experimental group: Comparison of the scores in scientific competences’ pre test-post test.

Graph 1 shows the scores obtained from each student in the pre and post test. To a first look, most of the students shifted their scores positively. Nevertheless, our statistical analysis shows that these results are not significant. We observe that the PM in conjunction with the IBSE do not cause a significative increase or decrease in the scientific competence level measurement by the test.

*Control group*

The graph 2 shows the scores of the control group, whose students had traditional lectures with the laboratory activities after those.

The results are not clear due to the heterogeneity of our results. These results shows that the traditional methodology, don’t affect the level of scientific competences achieved of the Chilean students. From the Wilcoxon’s W test, there is not a significant difference between the scores from pre and post test. Thus, from these results we can’t conclude an improvement in the scores.
Comparison between experimental and control group.

In order to carry out this comparison between the average scores (see Graph 3), the Mann Whitney’s U test was used. The Mann Whitney’s U test establishes if there were or not any significant differences between the results of both groups. By the p-value obtained through the statistic test we concluded that in the pre-test there is a significant difference between the scores of both groups ($p$-value=0,03696). Nevertheless, the post-test results shows that there are not any differences between the results ($p$-value=0,5966).

**Discussion**

Nowadays, there are plenty of different opinions about the application of Active Methodologies; on one hand, some researches established that if the students use active methodologies they would improve their scientific competences (Rao and DiCarlo, 2000; Crouch and Mazur, 2001; Fernández, 2006; Lorenzo, Crouch and Mazur, 2006; Castellanos and Zamudio, 2012); on the other hand, there are some that do not see the potential in the application of these methodologies (Leeds et al., 1998; Miguel, López and Martín, 2012). This research can be adjusted between both categories, because in spite of the positive results obtains, these were not as higher as expected.

One of the main factors that could influence the student results is their socio-cultural characteristics. The Chilean students are not used to participate or debate in class. The Peer Method needs the interaction and debate between the learners, and the environment of the classroom should be of confidence among them, to let them express their ideas freely. To stimulate the characteristics of this methodology in the Chilean students, before the implementation of this technique it should be applied a group activity to strengthen the students’ relationships and communication, and encourage them to participate in the class activities. Another important factor is the lecture continuity (Hernández, Javier and Martinez, 2013). In the school, the students have only 135 minutes of physics per week, 90 on Mondays and 45 on Fridays and as a consequence, they could not have the
continuity necessary between the lectures. Unfortunately this is unavoidable in the Chilean system, which curriculum compel the schools to make only 90 minutes per week.

**Conclusions**

Neither the experimental group students nor the control group obtained significant differences in the results before and after the intervention. However, when comparing the results from both groups during the pre-test, it was observed that these were statistically different, whereas when making the same comparison with the post-test results, it was found that these were statistically similar. This variation can lead us to conclude that, though when analyzing individually the results of the experimental group these didn’t present a significant variation, it does exist a small *improvement in the scientific competences level* achieved by this last group.

Additionally, this investigation opens the door to a lot of questions that might be addressed in later investigations. Among these, we can find:

- Would the results be different if we apply these methodologies in different subjects?
- How would the results vary if we apply these methodologies in other educational levels? For example, in primary school the students tend to participate more. Would this improve the results?
- Considering that the school where these methodologies were applied is a private school with a lot of resources; what would be the level of achievement of the students of an under-resourced school?
- If the school doesn’t count with a clickers system, it is still possible to perform the PM through the use of cards. Would the students react the same way?
- What would be the results obtained if we apply the methodologies for a longer time and without interruptions? Would the students have a better adaptation?

There are these and a lot of other questions that can be raised after this investigation. All of these have a common and only goal: to improve the learning processes and the acquisition of scientific competences by the students and increase their motivation in the scientific subjects.

**References**


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