**Analysis of Problem based learning (PBL) applied in heat transfer course for chemical engineering students.**

Bustos-Gutiérrez Paola1\*, Saavedra Jorge1, Reyes Laura1

*1 Universidad del Bío-Bío, Departamento de Ingeniería en Maderas, Escuela de Ingeniería Química*

*Avenida Collao 1202, Casilla 5C, Concepción, Chile*

*\*Corresponding author: pdbustos@ubiobio.cl*

**Highlights**

* PBL experience in heat exchanger design was successfully implemented.
* Third year students showed an important change in perception of acquired knowledge
* Leadership, autonomy and responsibility were determining aspects in collaborative work.
* Teams with good results were those with motivation and that saw their colleagues as source of knowledge.

**1. Introduction**

Today, Chemical process industries (CPI) have noticed that the difference between chemicals engineers they need and professionals who are being formed at universities is actually big [1]. CPI need people with skills like, team work, communication, creativity and critical think, among others. With this in mind, universities have gradually changed their educational models from “teacher centered” to “student centered”. So, academics have been forced to change their classical lectures to the use of active methodologies.

Among many others, problem based learning (PBL) has shown be able to motivate students because PBL is based in real situations, so, students feel closer to professional world [2]. Also, specifically in engineering, it has been reported that PBL is an effective tool for significant learn and for acquire several soft skills needed in the current industry [3].

**2. Methods**

PBL intervention was done in heat transfer course for chemical engineering students who were in 3rd year (from 5,5 years). Teams with 4 o 5 students were formed and each one received a different practical problem. The main goal of all problems was the heat exchanger design. Students were characterized with Perry’s inventory and a test of long learn skills [4]. PBL was performed in 8 sessions of 80 minutes each one. Teams analyzed problem, did brainstorming, defined learning objectives and thought about the best solutions that could be implemented. Evaluation was done in different ways and in different moments of PBL process, so, rubrics were constructed. Self and peer evaluations were considered too. At the end, students answered surveys that measured team work quality and their perception of acquired knowledge during the intervention.

**3. Results and discussion**

Perry’s inventory shows the maturity of students in order to face PBL experience, in this work, they averaged a Perry´s level of 3,5±0,3, which is consistent with their academic level and implies they yet need some teacher accompaniment as guide learning [4]. Even this, it is important to mention that teams with the same Perry´s level did not always have the same performance.

|  |  |
| --- | --- |
| Before | After |

**Figure 1.** Percentage of responses to the statement “I know what overall heat transfer coefficient is”

Regarding the perception of knowledge, figure 1 shows the change produced in a particular conceptual aspect related to heat exchangers design. This behavior was repeated with other eight conceptual and proceeding aspects. There were no variations in attitudinal aspects, maybe because the time spent in this work was not so long. There were interesting changes in long learn skills, especially in seeing the peers as a reliable source of knowledge. Teams who improved in this aspect were who showed the best performance at the end of the experience. Concerning team work, leadership, was one of the important points associated to disagreement. Responsibility and autonomy in assigned tasks were an important source of conflict too. In spite of this, all teams finished the activity and 86% of students pointed PBL as a good methodology and strategy to do the connection between university courses theory and professional reality.

**4. Conclusions**

(i) In addition to Perry´s level, motivation and frustration management affected performance of the teams. (ii)The more conflictive aspects of collaborative work were: type of leadership, autonomy and responsibility. (iii) When students saw their peers as valid sources of knowledge, team work was improved. (iv) Most of students rated PBL experience as enriching, academic and personally.

**References**

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