Scaffolds to support the development of scientific skills in physics

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Abstract. This paper responds to the social demand to equip learners with the skills capable to create solutions that are sustainable over time, to increasingly complex problems. To this end, this study designed implemented and evaluated an instructional process aimed to students' development of scientific skills during the scientific inquiry process. A quasi-experimental study was designed in which participated 61 university students of physics university course participated in the study. The results show that the students of the experimental group developed higher level of scientific skills than the control group.

1 Introduction

This study is supported by two theoretical axes; the first one is the scientific inquiry, which according to [1] plays an important role in the teaching and learning of science because it requires students to activate theoretical knowledge, scientific skills and social attitudes to solve problems. In addition, according to [2] teaching through inquiry generates teaching and learning situations that promotes students' development of a mindset related with the skills and the ways of knowledge building in science.

The second theoretical axe is a sociocultural perspective of learning in which learning is explained through the interaction processes that takes place among students and teacher and the quality of the scaffolds that are provided and the scaffolding processes created during learning. The term "scaffolding" was used for the first time by [3] and it refers to a structure of aids designed to accompany the student from the beginning of the learning process, but It will be gradually dismantled until it disappears when the student is able to perform the desired task on his/her own. These scaffolds are classified by [4] in the following manner: conceptual, metacognitive, procedural, and strategic; later [5] it was incorporated technical scaffolding.

The research question under investigation in this study is:

What is the impact of the scaffolds designed in the study on students' development of scientific skills?

2 Methodology

A quasi-experimental methodology was designed, with a control group who followed a traditional physics classes, and an experimental group that participated in a challenge-based learning. The instructional process consisted of solving a challenge in which students had to answer the following question: With what angle is the greatest horizontal distance reached in a movement in two dimensions?

In order to solve this challenge, students should follow the phases of scientific inquiry. The instructional process focused on supporting this process by giving specific scaffolds such as: demonstrations and classroom experiments (conceptual and metacognitive scaffolding), computer simulations and the analysis of videos of the experiment (procedural, strategic and technical scaffolding).

Likewise, to evaluate the level of development of scientific skills, an evaluation test was designed and applied before and after the intervention. This test was related with an experimental problem about the experimental determination of the elastic constant of a spring, description and data in the form of a table was provided. Students had to answer ten questions related to the phases of problem statement, experimental design, data processing and drawing conclusions.

Subsequently, coding scheme was elaborated in order to study the scientific skills used by students to solve the problem. This coding scheme is based on the one elaborated by [6] and it relates the scientific skills with different level of cognitive complexity (Fig. 1). In this way, a scale from 1 to 4 was created, where 4 corresponded with an advanced skill level, 3 integrated, 2 intermediate and 1 rudimentary.

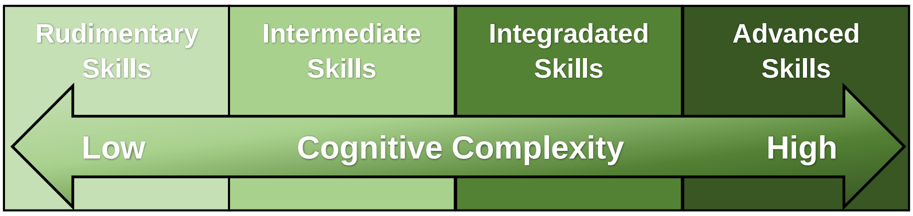

Fig. 1. Classification of scientific skills according to the degree of cognitive complexity. Adapted from [6].

3 Results

In the pre-test, 86.8% of the students in the experimental group and 95.7% in the control group had a rudimentary level of scientific skills. While, in the post-test 55.3% of the students in the experimental group reached an intermediate level and 82.6% of the control group remained at a rudimentary level.

4 Discussion

The results obtained by the students of the experimental group suggest that the different types of scaffolds designed in our study helped students' development of scientific skills. On contrary, the control group that followed a more traditional teaching methodology in physics did not develop these scientific skills. Therefore, our study opens up a promising path in introducing teaching methodologies in physics that focus on: challenge-based learning and the design of appropriate scaffolds to support the skills involved in an inquiry scientific inquiry.

References

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