Chapter 13
Measurement Instruments to Motivate Scientific Learning by Conceptual Change

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ABSTRACT

The purpose of this study was the development and adaptation of three instruments for the measurement of scientific reasoning, motivation and interest of students towards learning science. Sixteen students of the Bachelor in Aeronautical Engineering answered the questionnaires; they vary in age and gender. The first tool was a questionnaire to measure student motivation toward science learning (MAAC) obtained an overall Cronbach alpha of 0.771. A second instrument for measuring the scientific reasoning (PRC) obtained a Kuder-Richardson 20 formula estimate reliability of .751. The survey of student interest for issues related to science obtained a Cronbach alpha of .845. The study findings confirm the validity and reliability of all instruments. The implications of using these instruments as supports for measuring conceptual change in the students are discussed in the document.

INTRODUCTION

Around the world, governments have invested economic resources to launch programs that support and improve education. In this context, Mexico is no exception; the National Development Plan 2013-2018 states on its third object, strategy 3.5.3 the need to promote the development of scientific, technological and innovative aptitudes and capabilities (Gobierno Federal, 2013).

The characteristic of this new society has marked new radical changes on what is understood by learning and by construction of new knowledge. A challenge of big importance for higher education institutions is to enhance the capacity to learn and, above all, the capacity to understand scientific concepts in students.

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on subjects related to science. It is possible that the concepts the student has gained before lack scientific comprehension. Students have learned how to solve problems and equations, but they can rarely state the scientific basis the concepts involved; they know the how, but not the why. On a globalized society, massive production systems leave little space for people to ask themselves how anything works. Because of that, it is important that the schools for pre-service teachers and universities that form educators and their professors find a way in which the students can modify their ideas and preconceptions. Perhaps those preconceptions could be seen as false or incomplete, from other more scientific vision. Students are not just simple repeaters of information, they need to improve their comprehension of the phenomena so they can offer society better solutions to current problems.

The modification of non-adequate or incomplete ideas for others more exact and complete is called conceptual change. In order for students to generate this change, it is necessary to support them in different ways. The motivational component is an important foundation to achieve that end.

This document presents a study of previous scientific concepts of college students, and their motivation to comprehend them. The aim was to generate a conceptual change in students by introducing scientific information in a different way, with the intent to help them acquire an exact view of certain scientific phenomena. Finally, this document presents the evaluation of validity and reliability of three different instruments designed to measure student motivation, interest, and scientific reasoning.

LITERATURE REVIEW

Learning

To define learning is a complicated task. According to Lozano (2008), learning is the acquisition of new knowledge to the extent of generating new behaviors. From a constructivist point of view, learning is a process in which an individual is actively involved in linking new ideas to previous ideas and current experiences (Kuan-Hue & Hsiao-Ching, 2010). On the other hand, Vosnaidou (1996) references that learning involves the acquisition and the use of complex systems of symbolic expressions represented by different means, like the use of oral and written language, algebra, calculus, the use of tables, graphics and all the formalisms that science requires to manipulate and understand the significance and the interrelationships between different kinds of representations of the same information.

The process of learning has different characteristics. For example, it allows to modify what has been learned before, and it has an adaptive character. In addition, not all organisms have the same capacity for learning, which depends on the genetics of the individual, and the environment. Chi (2008) mentions that in the case of incomplete knowledge, learning can be conceived as something like filling empty spaces or voids, and in the case of incomplete or missing knowledge, learning becomes an act of enrichment.

There are several postures about what is basic in the process of learning. Saint-Onge (2000) describes four ideas as the basis of learning.

1. **Learning is an Activity**: This means that the student does the work. It depends on how the subject treats the information, and this is what ultimately determines the quality of learning.

2. **Learning is a Process of Construction**: Students learn to build their own cognitive structure, and this always begins with the existing cognitive structure when a learning opportunity arises.
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