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Should the third Newton's law be the first one? A TLS on dynamics for upper secondary school

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Abstract. In this paper we are presenting the design and evaluation process of a Teaching Learning Sequence (TLS) following Design Based Research (DBR) methodology. The TLS was designed for the upper secondary school students on particle dynamics. In this work, we present the very first results of the process. The iterative DBR methodology is presented giving evidences about design decision and tools for evaluation. This TLS was implemented in a post compulsory high school in the Basque Country. The results obtained in the first implementation show that there are improvements in the learning achieved by students in comparison with a control group. The strengths and weaknesses of the TLS will be analyzed for future redesign phase into DBR phases,

1. Introduction

Dynamics, probably, is the most popular topic in physics, particularly in secondary and high school. There are plenty of research works on students' difficulties in Dynamics and the difficulties are very well established due to very well known questionnaires like Force Concept Inventory (FCI) [1]. Although there are also some proposals for implementation with the aim to overcome those difficulties most of these proposals do not make explicit the design decisions and the evaluation of the proposal is usually done only looking to the students' results, leaving at the side the evaluation of the quality of the sequence. In this work, we are going to describe the design and evaluation process of a Teaching Learning Sequence (TLS) following Design Based Research (DBR) methodology [2, 3].

The principal aim of the TLS we are presenting in this work is to give students a learning path to follow to achieve a conceptual understanding on Newton's Laws and dynamics. With this purpose the present TLS would like to be "both an interventional research activity and a product, like a traditional curriculum unit package, which includes well-researched teaching-learning activities empirically adapted to student reasoning" [4].

To design the TLS we choose DBR methodology. This methodology allows us to integrate theoretical principles in the design process at the time that we can make explicit the design and evaluation decisions [2, 3]. This methodology proposes to follow three general steps; design phase, the teaching experiment and the analysis and evaluation of the teaching experiment and finally, a redesign phase. Although DBR methodology does not propose any commitments in relation to the nature of learning or teaching strategies, is expected the articulation of those commitments in the decision making process.

In this paper we are going to start answering the following research question. To what extent does the DBR methodology improve the design, evaluation and refinement of the TLS in the case of Newton's laws in high school students?

In summary, in this paper we have developed a way to use DBR as a methodology for the design of a TLS and we have provided an example developed following this methodology with a particular focus on its design and evaluation. We do not suggest that this is a unique result, but we hope it will be a fruitful contribution to change what is now a significant area of research, but to disperse in a research program that may constitute a central component of the field of Science Education.

4. References

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