Promoting physics teaching through student centered activities

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Abstract. Based on constructivism, on cognitivism and on the development of students' mental models about physics concepts, one reports the characteristics of a pilot study to serve as a guide for physics teachers' in-service education courses to promote and coach attitudinal changes towards stronger student centered teaching behaviors. Simultaneously, one searches for the evolution of students' misconceptions since first learning contacts with physics teaching in schools.

1 Introduction

Even at the birth of XXI Century, physics teachers continue to process their professional duties using mainly teachers' centered methodologies, which lead students to memorization of facts and train them into the use of formulae lists for problem solving. Training and memorizing are important activities within behavioristic theories about learning.

Recent educational research works based on constructivism point towards the higher efficacy of student centered teaching activities in schools, emphasizing the need of transferable students' cognitive, social and attitudinal competences to better prepare their future in a competitive and rapidly changing technological world. Some of these studies associate learning with development of students' mental models, establishing parallels between students' learning in schools and the creation of physics new scientific models by researchers.

The present study is a follow up of a communication presented during FFP15 [1] and aims at answering the following questions:

- Is it possible to induce an attitudinal change on in-service physics teachers, imposing a stronger student centered teaching behavior sustaining discussions, arguments and meaningful questioning in the classroom? How will students react to this change?
- Will teachers' awareness of students' mental models influence the characteristics of students' misconceptions created/developed from first contacts with physics teaching?

2 Theories, Context and Background

Physics teaching in schools follows a long tradition of teachers centeredness [2,3], influenced by behavioristic conceptions of teacher education, where priority is given to planning the lessons and keeping practices close to what was planned. To justify this type of teaching behavior teachers invoke long curricula, shortage of teaching time and lack of published materials to help supporting discussion activities. Sometimes they also recognize having educational deficiencies either in physics and/or in pedagogical knowledge [2].

Very recently, OECD and Portuguese government documents [4,5] point towards the importance of developing transferable learning competencies in schools, specifically the ones

enhancing life-long learning attitudes believed to be most useful in the near future due to the uncertainty about coming professional needs.

The concept of learning physics through the development of students' mental models [6,7] is present in recent physics teaching literature, which establishes parallels between researchers' activities to produce new scientific theories – actively presenting ideas to colleagues, explaining and discussing them, experimenting, producing theoretical and empirical arguments – and students' efforts to understand the physics models [2,3,6,7]. They recognize that each of these actions has to be present in students' centered physics teaching and recommend a strong emphasis on the implementation of group work strategies in school.

3 The study

We are developing a practice-based educational research [8] performed by a team of three experienced schoolteachers and two university professors of Didactics of Physics with practice of in-school stage supervision of physics teaching candidates. The study started in September 2017 and its first phase will finish in June 2018. In Portugal, the same teacher teaches Physics and Chemistry, one semester each. Hence, 7th grade (teacher JT) and 9th grade (teacher MS) physics classes finished in February 2018, and the processing of learning results has just started. 8th grade results (teacher AP) will be available in June 2018.

This pilot study is running, allowing the creation of leading experience and the writing of documents to guide future extended replications inserted within in-service teachers' education courses [9]. In the focused levels, the physics contents spread from kinematics and dynamics of linear motion (only one direction) up to astronomy, sound, light, fluids and electricity.

The research methodology is mostly quantitative, quasi-experimental, with control samples; pre- and post-tests focus on known physics misconceptions and ways of testing them, and some were adapted from the Force Concept Inventory. We are also collecting data through a survey on students' expectations about physics learning [10], adapted to school students.

All data processing will be finished by July, before the GIREP meeting, where we hope to present and discuss the inferred conclusions.

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