Evaluating knowledge and assessment-centered reflective-based learning approaches in a first year physics class

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Abstract. This paper addresses the development of knowledge and assessment-centered learning approaches within a reflective learning framework in a first year physics class in a university faculty. The quality of students' reflections was scored using a Self-reporting Reflective Learning Appraisal Questionnaire at the end of each learning approach. The results showed the differences between the approaches based on reflections on the learning control through self-knowledge, by connecting experience and knowledge, as well as through self-reflection and self-regulation. Assessment-centered activities fundamentally help students identify aspects of their attitudes towards, as well as regulate, their learning.

1 Introduction

The initial objective of this study was to investigate three approaches to teaching physics, namely, the knowledge-centered approach (KA), the formative assessment approach (AFA) and the structured formative approach (SFA). This study attempts to explore students' reflection processes when subjected to dynamic methodologies in a first year physics classroom. Although research-based instructional strategies have been implemented in physics education, little research focusses on developing self-reflection skills and appropriate views about knowledge and learning related to improvements in conceptual understanding. The study's second objective was to obtain students' views on the benefits, obstacles and limitations of incorporating reflective learning methodologies into the physics class itself and the design of the activities. This information was essential when evaluating the subsequent experiences. Specifically, we aimed to understand students' views on reflective learning methodologies in relation to self-knowledge, the relationship between experience and knowledge, and self-reflection and self-regulation. Our study quantifies the students' perceptions of the influence the three teaching approaches used in the physics class had. We consider individual aspects such as knowledge about oneself, connecting the experience with prior knowledge, and learning self-reflection and self-regulation. Quantification was based on the information obtained from a Self-reporting Reflective Learning Appraisal Questionnaire (RLQuest hereafter), which was completed by the students at the conclusion of the proposed approaches.

2 Methodology

The experiment was carried out with a regular group of students in a first-year university physics classroom. The experiment group was asked to follow a sequential reflective methodology by initially viewing physics experiments, then through open-class discussions, next by writing a report on the experience, and finally, by reflecting on the experience. The teacher organized the activity around a set of physics experiments and defined the taxonomy of concepts and topics to be covered. The basis of the approaches was either experiments taking place in the classroom or watching experiments on a video. Each approach consisted of four activities (whether they were video-cases or in-class experiments) therefore, the full proposal composed 12 activities. In the first

set of activities, a knowledge-centered approach (KA) was established in which conceptual understanding and organization of the knowledge was encouraged. In the second activity, students were asked to describe four physics activities, but this time with an assessment-centered approach as the teacher also suggested a series of formative questions to promote positive feedback (AFA). In the third case, a contextualized approach was used in which the teacher contextualized knowledge instruction and reflective learning by referring to authentic practices encompassing the first and second approaches (SFA). Students wrote a report on each of the four activities based on ten reflective questions and six questions to guide the students through the process of describing a scientific experiment. They are aligned with the early stages of the Kolb's model where learning processes are particularly enhanced through abstract conceptualization.

3 Results and discussion

Step-by-step instructions, corresponding to student-centered activities, guided first year students in an effort to improve their understanding of the fundamental concepts of physics. The findings in this research suggest that higher levels of comprehensive physics learning can be achieved when students receive formative feedback in a system of guided instructions. The results suggested that students' attitudes, as well as the regulation of students' learning, were a result of the methodology in combination with the process of reflection. Our results show that student-teacher interaction is an important factor in determining student learning experiences. Students who participated in the reflection process rated highly the questions related to self-regulating learning. The structured formative approach produced maximum reflection in terms of planning, regulating and evaluating students' learning. Students demonstrated a greater degree of reflection when the teacher promoted the structured formative approach (including guided instructions) prior to the reflection process, along with the teacher's assessments after the reflection process. This combination was evaluated higher than that of the knowledge-centered approach (i.e. without instructions or teacher feedback), or the formative assessment approach, which did include feedback from the teacher.

4 Conclusions

The cyclical process applied in this research might suggest that reflection is a cumulative process in which experience is the foundation of learning and that Kolb's dimensions may in fact enhance classroom activities. The application of Kolb's experiential learning cycle has also been reported in chemical engineering and industrial engineering classes as well as engineering laboratories. These studies claim that knowledge retention from engineering laboratory classes based on balanced learning experiences, with the inclusion of the stages of Kolb's experiential learning cycle, led to a deeper learning and longer retention of information. The theoretical basis of both collaborative and reflective learning is constructivism which states that learning is an active process of constructing knowledge rather than acquiring it. In this respect, reflective learning represents a process in which the learner's paradigm is promoted, i.e. a process in which values, attitudes and beliefs contribute to effective and grounded learning.

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