Making Teaching Physics Cultural – a New Paradigm and its Application in a Summary Lecture

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Abstract. Physics teaching widely varies in strategy and content in addressing various populations of students at their level, goals, interests. We have developed a new approach to the structure of physics course which is appropriate for broad range of levels and goals. It implies a universal demand of identification knowledge items, the structure of a theory based knowledge. The curriculum should represent *Nucleus*, *Body* and *Periphery* of the theory. It is the latter that makes knowledge cultural. We illustrate by a summary lecture in school mechanics which demonstrated significant impact on students' knowledge, its holistic perception and nature.

Introduction

An introductory physics course usually incorporates a great number of concepts, laws, models, phenomena explanations and solved problems. Textbooks usually present all these without explicit structure and hierarchy. The important cultural features of knowledge are left for the "hidden" curriculum [1]. Furthermore, material is presented in a univocal (disciplinary) manner while meaningful learning requires conceptual variation, a space of learning [2]. Our studies suggested considering physics knowledge as a culture of rules [3, 4] structuring the physics curriculum as discipline-culture (DC) [5]. The new paradigm was applied in several platforms. Of them, we depict here a summary lecture of mechanics in high school [6]. The new approach aims at promotion of the cultural content knowledge (CCK) [7] of the subject matter.

Theoretical framework and research questions

The DC conceptual framework recognizes science as a theory of nature denoting science as a cluster of domains of knowledge, each drawing on a fundamental theory. Secondly, each such theory can be presented as a culture of rules structured in *nucleus* (basic concepts, principles, laws), *body* (phenomena explanations, solved problems, empirical laws, experiments, etc.), and *periphery*, incorporating elements in opposition to the nucleus – alternative conceptions, unexplained phenomena and unsolved problems. This framework matched our research questions:

- In what way can a single lecture on classical mechanics meaningfully and feasibly summarize the subject of the physics course on mechanics?
- What is the impact on the content knowledge and its affective perception of such a lecture on the students of classical mechanics?

Method

Research sample and Educational context: 74 students, including groups of high school and teacher-training college students, after a regular course on mechanics. Our summary lecture represented the DC structure of mechanics being constructed in front of the students in the form of a continuous, partially rhetorical conversation. It drew on the course content, reinforced by several novel elements of the nucleus and completely new elements of the periphery.

Data collection and analysis: The assessment of the study included a questionnaire comprised of 21 multiple-choice questions, augmented by an option for a different answer. The questions addressed the holistic understanding of mechanics. Students responded in pre- and post-tests. The quantitative comparison evaluated the impact in terms of the size effect. The qualitative assessment analyzed students' comments to specific test questions.

Findings

We registered an important impact on the knowledge of the key issues such as the relativity of motion and the role of force (high 0.8), uniform rectilinear motion as a natural state of bodies, certain validity areas of theories and laws in science and the awareness of alternative conceptions (medium-large 0.6). A lower impact was registered regarding the ability to falsify alternative conceptions such as the obsolete force-motion conception (0.35). The qualitative evidence of the benefits of the summary lecture testified to the positive perception. Students often expressed surprise at the novel content, and showed increased interest and curiosity, increased confidence, and greater satisfaction with a clearer vision of classical mechanics. It appeared that students had missed the holistic perception of mechanics as a theory, the meaning of theory, concepts, laws, models defined by the lecturer vis a vis the relevant context. No less important was the expressed wish to learn more about physics.

Conclusion (answer to research questions and impact of findings)

A summary lecture within the DC paradigm can meaningfully and feasibly represent the course of mechanics as a theory possessing coherent and hierarchical structure. It can upgrade students' knowledge from the disciplinary to the cultural content knowledge of the subject matter. The suggested new teaching tool serves as a delay organizer of the disciplinary knowledge and encourages its reconstruction. Our experiment shows that the goal is feasible. Even after a single lecture, students appreciated the major feature of the CCK, its dialogism, the debate with alternatives, the explicit elaboration of its constructs (laws, models, concepts) which endows the meaning of classical mechanics as a fundamental theory. We believe that awareness of this kind is required. The positive affective impact of this curricular innovation multiplies the benefit.

References

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