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Teaching and learning cycles in a constructivist approach to instruction

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Abstract

This study attempts to analyze and synthesize the knowledge collected in the area of conceptual models used in teaching and learning during inquiry-based projects, and to propose a new frame for organizing the classroom interactions within a constructivist approach. The IMSTRA model consists in three general phases: Immersion, Structuring, Applying, each with two sub-phases that highlight specific roles for the teacher and the students. Two case studies, one for mathematics in grade 9 and another for science in grade 3, show how the model can be implemented in school, making inquiry realistic in regular classes. Beyond its initial purpose, the IMSTRA model proved to be a powerful tool in curriculum development, being used in producing mathematics textbooks, as well as in developing teaching courses for a long-distance teacher-training program.

Keywords: Inquiry; Learning activities; Teaching and learning cycle; Teaching models; Teacher's role

1. Setting the problem

A large body of literature, such as Cobb and Bauersfeld (1995), Resnick and Klopfer (1989), Sierpinska (1998), Singer (1999), and, probably most significant, the new curriculum guidelines in North American and European countries promote new missions for the teacher and the learner. These bring new roles into schools, which focus on:

- the **learner** as an *autonomous thinker* and explorer who expresses his/her own point of view, asks questions for understanding, builds arguments, exchanges ideas and cooperates with others in problem solving—rather than a *passive recipient* of information that reproduces listened/written ideas and works in isolation;
- the **teacher** as a *facilitator* of learning, a coach as well as a partner who helps the student to understand and explain—rather than a '*knowledgeable authority*' who gives lectures and imposes standard points of view;
- classroom **learning** that aims at *developing competences* and is based on *collaboration*—instead of *developing factual knowledge* focused on only validated examples and based on *competition* in order to establish *hierarchies* among students.

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However, compared with the effective results, all these new roles seem to pertain to a new ideology (e.g., Sierpinska, 1998). They require different processes in order to transform the new aims from ideal targets into outcomes of current teaching–learning practice. Another challenge arises from these new processes: the need to make the classroom interactions generate new mental frames for the ones involved, both the teacher and the student. The student's frame might be presumed as follows: "I am the student and I have to answer questions; but the teacher already knows the answers, so these are not real questions. Therefore, it is about my playing a role. And this role should not be taken very seriously; otherwise I risk being ridiculous." (Goffman, 1974). The teacher, on her part, too often sees the 'didactical contract' (Brousseau, 1980) in a limited formal way. The hidden understanding of the school as a stage, and of learning and teaching as formal role playing affects in-depth learning and the collaborative climate in the classroom. The questions are: How could these roles be made more realistic and exciting? How could teacher and students become partners in knowledge construction?

The model for the teaching and learning cycle we present in this article was developed as a follow-up of teacher-training sessions and revised as it was implemented at a school site. This paper presents an analytic description of the model. We start by providing an overview of the literature on learning cycles in various knowledge areas, with examples for sciences, mathematics, and interdisciplinary curricula. To make the basis for the construction more explicit, a teaching–learning experience in mathematics in 9th grade introduces the model and allows 'bootstrapping' into its description. The table-based presentation that follows can be used as a functional tool for teaching. A case study involving a set of science lessons in 3rd grade shows how the model can be applied, and is an example of the model's flexibility. Some possibilities for extending the model implementation are discussed in the end of the article.

2. Learning cycles in various areas

For a long time researchers tried to understand the different steps that one takes when solving a problem in an attempt to comprehend how the mind works and how to best educate the next generation. Are there set steps, or is it a conceptual template that allows for individual modifications according to the question under scrutiny, the researcher's background and the available resources? Various answers have been proposed to this question. We list some of them below.

2.1. The sciences

In the area of the sciences, there is an abundance of learning cycle models perhaps because science is perceived by the general public as the only bias-free and objective way of knowing. Generalizability and reliability studies suggest that results from one study can be easily duplicated if one follows procedures and uses the same materials as in the original study. These statistical entities also suggest that differences between the experimental group and control(s) can be correlated to the intervention rather than to random coincidence/mishap.

Looking at the role of the student in a problem-solving situation, Lawson, Abraham, and Renner (1989) reviewed several years of research on student reasoning and concluded that appropriate teaching can lead to generalizable and significant improvements. They identified three required stages meant to improve students' reasoning skills: exploration, term/concept introduction, and concept application. During exploration, students are encouraged to explore a phenomenon/phenomena and identify a pattern. The initial pattern gets reinforced, modified, or changed by using appropriate terminology and by exploring concepts during the second stage, which is term/concept introduction. The third stage, concept application, ensures that students are able to translate concept(s) learned and use them in new situations. Later, Lawson (2002) identified an increased difficulty in the problem-solving process that amplified the potential for reaching faulty conclusions when students explore science-related phenomena that involve unobservable entities. Lawson's conclusion is more disturbing as the students in his study are preservice biology teachers with at least a bachelor degree in the sciences. We noticed a similarity between the model proposed by Lawson et al. (1989), and the three levels of learning proposed by Wolfe (2001): concrete experience, representational or symbolic learning, and abstract learning.

In an attempt to enhance and clarify the engagement stage and integrate an evaluative dimension to the inquiry process, the Biological Science Curriculum Study (BSCS) developed a