Bringing authentic research to the biology classroom: The influence of a web-based research simulation in bioinformatics on comprehension of genetics

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Summary

The well established tradition of teaching science by inquiry among the various disciplines of science education suggests that learners should be provided with opportunities to participate in activities that represent the ways of the scientific community to acquire new knowledge. Current voices point to the differences between school inquiry tasks and authentic scientific tasks, claiming that most inquiry school tasks over simplify the complexity of the cognitive scientific processes and do not reflect the epistemology that underlie authentic science. Thus, it is suggested that school tasks be developed which reflect the cognitive processes and epistemology of real science.

The main purpose of this study is to explore means of bringing authentic scientific research in genetics into high-school biology classrooms. The study involves providing learners with a first-hand experience with authentic genetics research through a web-based research simulation, which makes use of authentic bioinformatics tools and heuristic strategies in genetics, to reveal gene function. The research simulation which takes into account high-school students' prior knowledge in genetics was developed on the basis of a research paper in which a gene of interest was identified, enables learners to cope with the scientists' steps through five sequential assignments. By using an example taken from the genetics discipline, this study is aimed to shed light on the potential advantages of harnessing the heuristic strategies and authentic bioinformatics tools and procedures for learning modern genetics at the high-school level. Nevertheless it may provide insights that can be extended to additional scientific disciplines. Thus, extending our understanding of the learning outcomes of positioning learners as participants of authentic research, adapted to their cognitive level.

In the course of this Thesis, I examined the impact of learning using a research simulation in genetics and bioinformatics on high-school students' understanding of modern genetics and how do students' approaches to learning using the environment influence their learning outcomes. In complementation to examining the processes that characterize learning using the research simulation, I studied the teaching strategies used by a high-school biology teacher to support students' progression through the research simulation in her classroom.

The results of this study, obtained using both quantitative and qualitative procedures indicate that learning using the research simulation promotes expansion of genetics knowledge. The results suggest a synergistic effect between theexpansion of genetic knowledge and the recognition of genetic-research practices, to achieve a better understanding of genetics compared to learning genetics through a more traditional instruction.

Two types of learners, research-oriented and task-oriented, were identified in lab settings on the basis of the differences in the ways they seized opportunities to recognize the research practices, which in turn influenced their learning outcomes. The research-oriented learners expanded their knowledge in genetics more than the task-oriented learners. The learning approach taken by the research-oriented learners enabled them to recognize the epistemology that underlies authentic research in genetics, while the task-oriented learners referred to the research simulation as a set of simple procedural tasks.

The enactment of the research simulation in a classroom was studied in a single classroom. The teacher dictated a research-oriented approach by applying a concrete pedagogical approach of discussing "why" to use a certain heuristic strategy and "how" to use it systematically in each of the research steps. In this way, the teacher was able to apprentice students to use their general inquiry thinking skills to acquire metastrategic knowledge about domain-specific heuristic strategies, which accompanied their concrete experience with the authentic research tools. These findings point to the important role of supporting acquisition of domain-specific metastrategic knowledge in making authentic research accessible to students. In addition, it points to a possible connection between acquisition of domain-specific metastrategic knowledge and expansion of disciplinary knowledge, as suggested above. Implications of the design of school activities which are aimed to position learners as participants in authentic research, and for supporting learners' participation in such research activities in class are suggested.