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A multi-modal, web-based inquiry learning environment on Genetically Modified Organisms

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Abstract

A multi-modal, web-based inquiry learning environment (LE) on Biotechnology and Genetically Modified Organisms (GMOs) is the focus of this presentation. The LE has been developed for use in science education as a means to raise students' interest in socio-scientific problems and create a bond between the scientific enterprise and human life through the use of new information technologies. The LE was built around the idea of software-based scaffolding, the role of which is crucial for successful reflective inquiry and synchronous and asynchronous collaboration among students. A design-based approach was followed for the development of the LE; the LE was designed by a Local Working Group (LWG) in Cyprus, piloted, redesigned and re-enacted in a high school class. The analysis of pre and post tests administered to students during the LE's reenactment demonstrated the effectiveness of the intervention; students' conceptual understanding and credibility skills were significantly improved by the end of the enactment. Such approaches can become the catalyst for making science education more attractive and appealing to students' learning needs.

Extended summary

1. Aims

Students' interest in science education has declined considerably during the past decade. A very low number of students wishes to pursue a career in science (Sjøberg & Schreiner, 2006), an indication that the "swing from science" phenomenon (Ormerod & Duckworth, 1975) still endures. This disinterest is attributed to schools' failure to sustain students' motivation to learn about science and a lack of authentic science teaching and learning. The role of new technologies is critical in this respect; they can be the conjunction between the scientific enterprise and human life, making science more appealing to young people. Integrating new technologies in the process of learning science - not only learning *about* but also learning *with* technology would be highly beneficial. In this study, we present one such approach. A multi-modal, web-based inquiry learning environment (LE) about Biotechnology has been developed on the STOCHASMOS platform (Kyza & Konstantinou, 2007) allowing students to learn about a socio-scientific

issue working on a project-based investigation which integrates reflection, collaboration and scaffolding. This work was implemented under the European project "Digital support for Inquiry, Collaboration, and Reflection on Socio-scientific Debates" (CoReflect), the aim of which is to develop and validate a multi-lingual library of web-based, multi-modal inquiry LEs for use in science education.

2. Theoretical framework

The idea of scaffolding underlies the development of the presented LE. In the study of socio-scientific problems, scaffolding is of core importance (Davis, 1998) since learning is often based on understanding complex data sets which without appropriate scaffolding can become major obstacles for students' understanding. A software-based scaffolding mechanism is embedded in the development of the LE assisting students' reflective inquiry. Reflection is perceived as an ongoing process of students' thinking about and with the data, practiced throughout the learning process. The LE we present provides supports for organizing, analyzing, synthesizing and communicating evidence-based explanations promoting reflective practices. Finally, the software-based scaffolding supports collaborative learning practices specifically synchronous and asynchronous communication among students and between students and teachers.

3. Description of the web-based inquiry LE

The web-based inquiry LE consists of two environments: an authoring environment, in which teachers can develop web-based environments for use in the classroom and the students' inquiry environment, in which students collect, explain and organize data communicating their understanding of the socio-scientific issue at hand. The latter is the focus of this presentation. The students' learning environment is composed of (a) the inquiry investigation area, and (b) the reflective WorkSpace area, where students access template pages, articulation and inquiry management tools that help them structure their work. The topic of the LE was Biotechnology and Genetically Modified Organisms (GMOs). It was chosen because it affords authentic inquiries of multi-modal, rich scientific data and problem-based learning. The question driving the design of the LE was whether students would allow the growing of genetically modified plants in their country. Diverse sources of data for and against GMOs were accessible through the LE. The aims of the LE were for students to: (a) understand basic concepts related to Biotechnology and GMOs, (b) evaluate the credibility of evidence by applying specific criteria, (c) provide an evidence-based answer as to whether they would allow the growing of GM plants in their country.

4. Methodology/Research design

The development of the web-based inquiry LE presented in this ICT demonstration is the result of the collective effort of a LWG in Cyprus consisting of university researchers, teachers, and scientists. Following a design-based approach the LE was first piloted in an 11^{th} grade class (n= 12) over eleven 90-minute lessons. The LE was then redesigned, refined and re-enacted with a different 11^{th} grade class (n= 21) over eight 90-minute

lessons. Pre- and post-tests were administered in order to assess the effectiveness of the LE. In particular, test items assessed students' conceptual understanding and credibility assessment skills.

5. Findings

Data from pre- and post-tests were statistically analyzed to evaluate the effectiveness of the intervention. Statistically significant results for both conceptual understanding and credibility assessment skills demonstrated the usefulness of the LE for students' learning, using non-parametric statistics, due to the small number of participants. Of 18 students, 11 had higher scores in the posttest on conceptual understanding (*Mdn*=7) and only 3 had higher scores in the pretest (*Mdn*=6). There were 4 ties. This difference was significant, *Z*= -2.24, p=.025, r=-.52. Similarly, credibility assessment scores as measured by the open-ended questions for evaluating credibility were significantly higher in the posttest (*Mdn*=6) than the pretest (*Mdn*=4), *Z*=-3.63, p=.001, r=-.85. Significant differences were also found for credibility assessment skills as measured by the 22-item scale, with *Z*=-3.41, p=.001, r=-.88. Scores in post test (*Mdn*=97.5) were higher than scores in pretest (*Mdn*=86.5).

6. Theoretical/educational significance

Teaching science and simultaneously promoting students' interest in scientific issues is a challenge educational systems are currently facing. This work presents an innovative way of meeting this challenge through the use of a web-based, inquiry LE that promotes collaboration, reflection, and scaffolding. The presented LE was found to be beneficial raising students' conceptual understanding and learning skills. Youth attitudes on the importance of scientific and technological issues to society are positive (Sjøberg & Schreiner, 2006) pointing out that the potential for making science attractive and meaningful exists. The step forward, therefore, is for school to become the catalyst for capturing students' interests and addressing their learning needs.

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