Can we increase students' motivation to learn science by means of Web-based Collaborative Inquiry?

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Abstract: This study hypothesized that web-based collaborative inquiry in science classrooms can be considered as a need-supportive environment which in turn can foster good quality motivation as conceptualized by the Self-Determination Theory (SDT). The results did not confirm the hypothesis of an increased autonomous motivation, however an increase of controlled motivation was found. We discuss how we can improve the teaching and learning environment to satisfy students' basic needs and improve good quality motivation.

Theoretical background

Many countries are facing a decline in motivation for science resulting in reduced numbers of young people choosing to pursue the study of science and a career in science. This finding has been one of the driving forces for developing and implementing computer-supported collaborative learning environments. CSCL environments are often perceived as motivating learning environments since students are connected to their peers and to technology they regularly employ for informal learning. However, to date the focus is more on theories of learning in CSCL settings whereas motivational analyses are still rare (Dillenbourg, Järvelä, & Fisher, 2009). Though, we need this kind of research to specify the exact motivational challenges of CSCL. To meet this gap, this paper focuses on the implementation of a web-based collaborative inquiry project in secondary science education and unravels if it can contribute to the aim of fostering students' motivation to learn science.

Motivation from a Self-Determination perspective

According to Deci and Ryan's SDT (1985) , motivation can be distributed along a continuum from low to high levels of self-determination. The most self-determined style of motivation is intrinsic motivation. In addition, several types of extrinsic motivation have been proposed each with a different degree of self-determination. From a high to a low degree of self-determination, there is identified regulation where the individual's behaviour reflects conscious values and is internalized as personally important; introjected regulation which represents a partial internalization without completely accepting it as one's own; and external regulation which takes place when a behaviour is performed for external rewards or constraints (Deci, Vallerand, Pelletier, & Ryan, 1991). The subcomponents intrinsic motivation and internalized extrinsic motivation on the one hand refer to *autonomous motivation*; external and introjected regulation on the other hand refer to *controlled motivation* (Vansteenkiste et al., 2009). Previous research within the SDT tradition has shown that an autonomous, relative to a controlled, regulation of study activities is associated with various positive learning outcomes (see Reeve, Deci, & Ryan, 2004, for an overview). Moreover, regarding science education more particularly, it has been found that the more self-determined students' science motivation, the more likely they should consider an education and a career within a scientific field (Lavigne, Vallerand, & Miquelon, 2007). In this respect, autonomous motivation need to be fostered.

Basic Need Satisfaction and Web-based Collaborative Inquiry

Within the framework of SDT it is maintained that teachers foster autonomous motivation when they create an environment that facilitates the satisfaction of three basic needs: 1) students' need for autonomy, 2) competence, and 3) relatedness (Vansteenkiste et al., 2009). First, teacher autonomy support involves the offering of choice, the minimization of controlling language, and the provision of a meaningful rationale. Second, the need of feeling competent can be supported by the provision of structure, including optimal challenging tasks, praise, encouragement after failure, and adequate help. Finally, to meet the third basic need of relatedness the provision of involvement is important which refers to the experience of a sense of closeness and friendship with one's student peers. This study put forth Web-based Collaborative Inquiry by means of the online learning environment WISE (Web-based Inquiry Science Environment, (Slotta & Linn, 2009) and hypothesize that implementing web-based collaborative inquiry in science classrooms can be considered as a need-supportive environment which in turn will foster autonomous motivation for science learning.

Methodology

The participants in this study were 220 students from 13 secondary school classes (grade 9 and 10). The average age of these students was 16 years. The ratio of males to females among the participants was 63% boys to 37% girls. The science teachers of these classes were asked to dedicate four class periods of 50 minutes to complete the intervention, i.e. the implementation of a web-based collaborative inquiry curriculum project. Students' motivation for science learning was measured by means of an adapted version of the Academic Self-Regulation Questionnaire originally developed by Ryan and Connell (1989), yet redesigned by Vansteenkiste, et al. (2009). This 16-item scale containing four items per regulation type has been successfully used and validated in the context of previous motivation research. In this study, the questionnaire has been conducted during a pretest and posttest to assess potential shifts in the quality of motivation. Internal consistencies for the eight-item subscales, as indexed by Cronbach's alpha, were satisfactory for both *autonomous motivation* (pretest $\alpha = .93$, posttest $\alpha = .94$) and *controlled motivation* (pretest $\alpha = .72$, posttest $\alpha = .85$).

Results & Discussion

Based on the results of this study, the hypothesis of an overall increased good quality motivation for science as a result of being exposed to web-based inquiry during secondary science education need to be rejected since no significant pre to posttest difference is found for *autonomous motivation* ($t = .04$, $df = 211$, $p = .97$). On the other hand an overall significant increase of *controlled motivation* is found ($t = -2.21$, $df = 211$, $p = .03$), but this does not result in more qualitative motivation profiles.

We need to conclude that higher learner motivation, which in this study meant more qualitative motivation, cannot taken for granted because of an innovative learning approach. This finding can be related with what Dillenbourg et al. (2009) described as 'the myth of media effectiveness'. This refers to the fact that entering new media in the educational sphere often generates over-expectations with respect to its intrinsic effects on learning. This finding force us to rethink the implementation of web-based collaborative inquiry in science education in light of the satisfaction of the three basic needs. Regarding autonomy support, we need to think about how we can provide students with more choice, for example with regard to the completion of inquiry activities. Regarding competence support, although it is found that most students don't have operational problems during computer-assisted learning, a lot of students struggle during information problem solving on the web (cf. the myth of the digital natives). Next to scaffolding for domain-specific knowledge, also scaffolding the metacognitive skills during CSCL need to be stressed. Regarding relatedness finally, as noticed by Blumenfeld et al. (2006), students need to adjust to a new relationship with the teacher who becomes a facilitator rather than the primary source of information, but also teachers need to adjust to a changing role which in recent years has become central concern in CSCL (Dillenbourg et al., 2009). In addition, although students are working together in small groups at the computer, this does not guarantee that they engage in collaborative knowledge construction and in shared regulation. The question how we can improve the probability that students communicate with each other, seek feedback from each other and jointly approach the learning activity and negotiate solutions to complex problems is also one of the challenges in CSCL research.

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