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An evaluation of students' motivation in computer-supported collaborative learning of programming concepts

Luis Miguel Serrano-Cámara, Maximiliano Paredes-Velasco, Carlos-María Alcover, J. Ángel Velazquez-Iturbide *

Universidad Rey Juan Carlos, C/Tulipán, S/N, Móstoles, 28933 Madrid, Spain

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ABSTRACT

Motivation is a very important factor for successful instruction. This factor is especially relevant in collaborative learning contexts, where social interaction plays an important role. In this paper we present an evaluation of motivation in 139 students who were instructed under four pedagogical approaches: traditional lecture, collaborative learning, collaborative learning guided by CIF (an instructional framework for collaborative learning), and collaborative learning guided by CIF and supported by MoCAS (a collaborative learning tool). We considered the four dimensions of motivation according to self-determination theory. The statistical results show that, in global terms, students were more motivated by jointly using the collaborative instructional approach CIF and the MoCAS tool than by using a collaborative approach. Detailed analysis of the different kinds of motivation yields mixed results. Students who were instructed with CIF and especially those students instructed with CIF and MoCAS exhibited higher intrinsic motivation. Furthermore, students instructed with CIF and MoCAS were the most extrinsically motivated via identified regulation. With respect to extrinsic motivation via external regulation, students instructed in a traditional, individual way were more motivated than students instructed collaboratively. Finally, high levels of amotivation were also associated to instruction using CIF and MoCAS. In summary, our results suggest that CIF and MoCAS are associated with high levels of intrinsic and extrinsic motivation, a finding that can aid in improving the learning processes, but they are also, unexpectedly, associated with amotivation, suggesting an overall increase in activation in the students who show mixed motivators.

1. Introduction

The European Higher Education Area (EHEA) promotes the use of instructional models where students play a more active role than in traditional instruction. There are different pedagogical approaches that encourage an active role of the student, such as problem-based learning (Dochy, Segers, & Van den Bossche, 2003; Ellis et al., 1998), project-oriented learning (Jones, Rasmussen, & Moffitt, 1997) or case-based learning (Harvard Business School, 2013). These approaches can be combined with collaborative learning if several students work together to achieve a common goal (Dillenbourg, 1999). The computer supported collaborative learning (CSCL) field gives computer support to these approaches.

In a previous work (Serrano-Cámara, Paredes-Velasco & Velázquez-Iturbide, 2011), we proposed an instructional framework aimed at designing and developing collaborative learning activities based on educational objectives, called CIF (Collaborative Instruction Framework). In short, CIF combines CSCL activities (Bonwell & Eison, 1991; Koschmann, 1996) and learning goals, stated in terms of Bloom's taxonomy (Anderson et al., 2001; Bloom, Englehart, Furst, Hill, & Krathwohl, 1956). CIF is supported by the system MoCAS (Mobile Collaborative Argument Support), which was designed to cope with a range of different screen sizes, from PCs to mobile phones.

The CIF framework has been used with students enrolled in a course on introduction to computer programming (usually known in the computing community as CS1). The learning outcomes of several instructional methods were compared (Serrano-Cámara, Paredes-Velasco & Velázquez-Iturbide, 2012). We obtained a statistically significant improvement in the learning outcomes of students jointly using the CIF framework and the MoCAS system. We also obtained anecdotal evidence of the higher motivation of these students. Given the importance of motivation for learning, we considered important to have more founded knowledge on the influence of CSCL on students' motivation.

The aim of this study is to evaluate student's motivation using CIF and MoCAS as CSCL materials. In order to obtain as much information as possible, we compared the same four instructional methods as

* Corresponding author. Tel.: +34 916647454.
E-mail addresses: luismiguel.serrano.camara@urjc.es (L.M. Serrano-Cámara), maximiliano.paredes@urjc.es (M. Paredes-Velasco), carlosmaria.alcover@urjc.es (C.-M. Alcover), angel.velazquez@urjc.es (J.Á. Velazquez-Iturbide).

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used in the previous evaluation of learning outcomes (Serrano-Cámara et al., 2012). The joint use of CIF and MoCAS is the experimental group and the three control groups instructed students: in a traditional form, in a collaborative form, and collaboratively with CIF (but without the support given by MoCAS). To conduct the evaluation, we measured self-determination and the four dimensions of motivational by means of the Situational Motivation Scale (SIMS) developed by Guay, Vallerand, and Blanchard (2000), in its Spanish adaptation and validation (EMSI, see Martín-Albo, Núñez, & Navarro, 2009).

The article is structured into several sections. Section 2 contains a description of the state of the art on motivation and CSCL in education, mainly in computer programming education. Section 3 describes previous concepts related to our research, namely the CIF framework, the MoCAS platform, and EMSI motivational motivation scale. Sections 4 and 5 describe the experiment design and method, and the results, respectively. Finally, in Section 6 we present a brief discussion and our conclusions.

2. Background

2.1. Motivation in education

Motivation has been a central issue in the study of human behavior, since it is at the core of biological, cognitive, and social regulation processes. In the real world or in a practical sense, motivation is highly valued because of its consequences: motivation helps produce positive results (Ryan & Deci, 2000a). Motivation is a core factor in the learning–teaching process to improve active learning (Pintrich, 2003), because motivation concerns energy, direction, persistence and equifinality – all aspects of activation and intention (Ryan & Deci, 2000a). The literature shows a high diversity in terms and approaches about motivation (Murphy & Alexander, 2000). From these different conceptual models, the self-determination theory can be a theoretical framework very useful to understand motivation within the educational and academic contexts (Deci, Vallerand, Pelletier, & Ryan, 1991; Vansteenkiste, Lens, & Deci, 2006). Self-determination theory (Deci & Ryan, 1985) emphasizes the importance of the development of internal human resources for personal development and self-regulation of behavior. Self-determination is based in intrinsic motivation, or prototypical manifestation of the human tendency toward learning and creativity, and in self-regulation, which is concerned with how the people assume social values and extrinsic contingencies and progressively transform these into personal values and self-motivation (Ryan & Deci, 2000a).

There are several dimensions of motivation depending on the level of self-determination, ranging through a continuum from more to less self-determination:

1. Intrinsic motivation refers to doing something because it is inherently interesting or enjoyable; intrinsic motivation is an important phenomenon for educators because it is a natural wellspring of learning and achievement that can be systematically catalyzed or undermined by instructor practices, and because intrinsic motivation produces results in high-quality learning and creativity (Ryan & Deci, 2000b).
2. Extrinsic motivation via identified regulation – a more self-determined or somewhat internal regulation – implies an option as it occurs when the behavior is considered important for the subject's goals and values.
3. Extrinsic motivation via external regulation – a less self-determined or more external regulation – refers to doing something because it leads to a separable outcome – to obtain a reward or to avoid a punishment.
4. Amotivation, the least self-determined dimension, implies non-regulation and occurs when individuals do not perceive the contingencies between the behavior and its consequences, and behavior has not intrinsic or extrinsic motivators (Ryan & Deci, 2000a).

These authors note that each type of motivation leads to different consequences. Previous research carried on from this model has shown that the most self-determined forms of motivation (i.e., intrinsic motivation and identified regulation) are more closely associated with positive consequences such as the natural propensities for growth and integration, as well as personal well-being and constructive social development. On the other hand, the most negative consequences, for instance, a low self-esteem and avoidance behaviors, are linked to lower levels of self-determination, such as amotivation and external regulation.

Moreover, self-determination theory postulates that social and environmental factors affect motivation, facilitating or inhibiting intrinsic motivation and its potential positive consequences. These factors are present in educational contexts, especially in collaborative learning and group active learning where social interaction, sensemaking processes and collective processes in distributing, sharing and interpreting information and knowledge play a central role (Alcover, Gil, & Barrasa, 2004). Research results point out that, rather than focusing on rewards for motivating students' learning, it is important to focus more on how to facilitate intrinsic motivation (Deci, Kostner, & Ryan, 2001). One of the environmental factors that may be more relevant in educational settings to enhance motivation refers to the learning strategies and teaching methodologies used (Schunk, Pintrich, & Meece, 2008). Therefore, to research the educational methodologies and group and collaborative learning from an intrinsic motivation view is very interesting and relevant in the EHEA context.

2.2. Collaborative learning and CSCL

There is a large body of documented experience about active learning from collaborative approaches (Keser, Uzinboylu, & Ozdamli, 2011). Collaborative learning refers to a situation where two or more people learn or attempt to learn something together: knowledge, skills, competencies and so on. Specifically, it is defined by a set of processes which help people interact together in order to accomplish a specific goal or to develop an end product which is usually content specific. In summary, following the conclusions of Dillenbourg (1999), the words "collaborative learning" describe a situation in which particular forms of interaction among learners are expected to occur, which would trigger collective learning mechanisms, but there is no guarantee that the expected interactions will actually occur. Hence, a general concern is to develop ways to increase the probability that some types of interaction occur, and to facilitate the achievement of the learning goals.

The crucial issue in collaborative learning is what may be called "practices of meaning-making in the context of joint activity", *intersubjective learning* (Suthers, 2005) or *group cognition* (Stahl, 2006). This learning is not merely accomplished in a group context or interactionally, but it is actually constituted of the interactions between participants (Stahl, Koschmann, & Suthers, 2006). In collaborative learning some factors are particularly important, such as group composition and functional roles of team members (Wang & Lin, 2007), team and task regulation processes (Saab, van Joolingen, & van Hout-Wolters, 2012), levels of interdependence and trust processes (Rico, Alcover, Gil, & Sánchez-Manzanares, 2009), or team and task awareness (Franser, Kirschner, & Erkens, 2011). They are factors that turn influence on motivation