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Promoting collaborative learning through regulation of guessing in clickers

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A B S T R A C T

Collaborative learning is a promising avenue in education research. Learning from others and with others can foster deeper learning at a multiple-choice assignment, but it is hard to control the level of students' pure guessing. This paper addresses the problem of promoting collaborative learning through regulation of guessing when students use clickers to answer multiple-choice questions of various levels of difficulty. The study is aimed at identifying how the difficulty of the task and students' levels of knowledge influence on the degree of partial guessing. To answer this research question, we developed two research models and validated them by testing 84 students with regard to the students' level of knowledge and the penalty announcement. The findings of this research reveal that: a) the announcement of penalty has a negative effect on promoting collaborative learning even if it leads to reducing pure guesses in test results; b) questions that require higher-order thinking skills promote collaborative learning to a greater extent; c) creating mixed level groups of students seems advisable to enhance learning from collaboration and, thus, to decrease the degree of pure guessing.

1. Introduction

Collaborative learning is a pedagogical approach, which helps to enhance learning performance (Blasco-Arcas, Buil, Hernández-Ortega, & Javier Sese, 2013; McDonough & Foote, 2015). In-depth research indicates that this type of learning environment leads to deeper learning while students teach each other by addressing misunderstanding and clarifying misconceptions. In the collaborative learning environment, students gain different perspectives and, thus, articulate and defend their own ideas. It was Lev Vygotsky who laid the foundations for collaborative learning (Vygotsky, 1978). His concept of learning, called the zone of proximal development, cast doubt on knowledge-based tests as a proper means to measure students' level of knowledge. Vygotsky contended that, in order to gauge the level of true knowledge, it is required to examine an ability to solve problems both independently and in a group. But measuring the knowledge of students who are working in a group is a complicated problem.

One way of stimulating peer collaboration and, at the same time, measuring individual performance is using clickers (Brady, Seli, & Rosenthal, 2013; Chien, Chang, & Chang, 2016; Cook & Calkins, 2013; Lantz & Stawiski, 2014; Lantz, 2010; Mayer et al., 2009). Some studies highlight the effectiveness of this method because it promotes active learning through student engagement (McDonough & Foote, 2015). For instance, in their research, Smith et al. (2009) used clickers to test in-class concept questions. At first, students were asked to answer a question after a peer discussion. Then, they were posed a similar clicker question, but they followed the instruction to give an answer independently. Smith et al. (2009) analyzed the improved percentage of correct answers after peer discussion. The authors offered two possible explanations for higher grades: the result of conceptual understanding or simply the outcome of choosing the answer most supported by more knowledgeable peers. The authors concluded that the peer discussion led to better understanding even when none of the students knew the correct answer. Although this research shed light upon the major problem of distinguishing between actual learning from students' collaboration and the influence of more prepared students on their peers, there seemed to be some problems with assessing learning performance accurately.

This assessment problem partly results from the limitations imposed by the testing format: clickers are traditionally used in multiple-choice testing (Little & Bjork, 2016). There are two major

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issues of multiple-choice testing, which are widely debated in the literature.

The first issue is designing questions which go beyond Bloom's lower-order thinking levels: *recalling*, *understanding*, and *applying* to the higher-order levels: *analyzing*, *evaluating*, and *creating* (Anderson et al., 2001; Bloom et al., 1956). On the one hand, some studies (Anderson et al., 2001; Mayer, 2002; Ventouras, Triantis, Tsiakas, & Stergiopoulos, 2010; Ventouras, Triantis, Tsiakas, & Stergiopoulos, 2011; Thelwall, 2000) point out that it is possible to design multiple-choice quizzes that test higher-order thinking skills. On the other hand, some researchers argue that multiple-choice assignments are deemed to measure only factual recalling (Butler & Roediger, 2008; Nickerson, Butler, & Carlin, 2015; Nicol, 2007). Therefore, many instructors offer the easiest way to manipulate test difficulty, i.e. to vary the number of multiple-choice alternatives (Butler & Roediger, 2008; Dehnad, Nasser, & Hosseini, 2014; Lesage, Valcke, & Sabbe, 2013; Tarrant & Ware, 2010). But an increase in the number of distractors may lead to a decrease in proportions of correct responses. Students are likely to acquire false knowledge instead of enhancing retention of the material. As a result, such test format may increase students' exposure to misinformation. Butler & Roediger (2008) indicate that a distractor has the most detrimental effect unless proper feedback is provided Nicol (2007).

An opposing view is suggested in Bjork's recent research (Bjork, Little, & Storm, 2014; Bjork, Soderstrom, & Little, 2015; Little & Bjork, 2015), where it is stated that multiple-choice testing can promote deep learning and increase long-term retention even when no corrective feedback is given. In accordance with these studies, multiple-choice testing can stimulate the type of retrieval processes known to improve learning (Bjork et al., 2015). In this case, instructors need to provide students with a metacognitive strategy to encourage more complex thinking. This strategy is aimed at considering all the alternatives to cogitate not only why the selected answer is correct, but also why distractors are incorrect. Moreover, students should engage in this metacognitive strategy even if they are certain what answer is correct.

However, applying metacognitive strategies may pose the other serious assessment problem: if students can eliminate some responses based on critical analysis, they can get the correct answer with partial guessing, the level of which is often difficult to assess correctly (Ben-Simon, Budescu, & Nevo, 1997; Kubinger, Holocher-Ertl, Reif, Hohensinn, & Frebort, 2010). An extensive body of literature puts forward different scoring procedures to examine partial guessing (Arnold & Arnold, 1970; Bereby-Meyer, Meyer, & Budescu, 2003; Espinosa & Gardeazabal, 2010; Lord, 1980). The primary purpose of these methods is to alleviate pure guessing effects on multiple-choice items and, thus, to reveal students' true knowledge. For instance, Ghafournia (2013) attempted to approach this problem analysing test-taking strategies in answering multiple-choice tests at three levels of English proficiency. The author studied the following subcategories of strategies: time management, error avoidance, guessing, and intent consideration (Ghafournia, 2013). The findings of this research demonstrate significant differences only in using guessing strategies across the three levels of proficiency. While the higher level students used the error avoidance strategy and the time management strategy more frequently, the lower level students employed the guessing strategy less regularly. In contrast to the results of the lower level group and the higher level group, the intermediate level students used the guessing strategy to a much greater extent. These results could be interpreted as follows. The higher level students have a sufficient level of knowledge to answer questions, so they do not need to heavily rely on the guessing strategy. By contrast, the lower level students take pure guesses as they may not have enough knowledge to adopt guessing as a strategy. Finally, the intermediate level students have only partial knowledge. As a result, they demonstrate some partial guessing in attempt to avoid distractors. Consequently, the level of guessing depends not only on the order of thinking skills, but also on the level of students' knowledge.

What is not specifically tackled in the studies reviewed above is how the levels of cognition and students' levels of knowledge influence on the degree of guessing. This is the research question raised in this study. Addressing this gap with regard to collaborative learning, we stated the **objective** to look into the problem of promoting collaborative learning through regulation of guessing in answering clicker questions. Firstly, we support the idea that clickers can be seen as an effective instrument for promoting deeper understanding and improved students' performance via collaboration. Clickers can help to develop students' critical thinking skills (Blasco-Arcas et al., 2013; Brady et al., 2013; Levesque, 2011), especially when designed questions are based on a taxonomy to encourage higher-order thinking (Bode, Drane, Ben-David Kolikant, & Schuller, 2009; Bruff, 2009; Cook & Calkins, 2013). Secondly, the process of collaboration is not limited to applying only cognitive and metacognitive strategies. It also involves such aspects as social and metasocial interaction (Wang, Wallace, & Wang, 2017). Consequently, the regulation of this process is crucial for creating an effective learning environment. Though there is research into different types of regulation (De Backer, Van Keer, Moerkerke, & Valcke, 2016; Jarvela & Hadwin, 2013; Jarvela & Hadwin, 2015; Jarvela, Malmberg, & Koivuniemi, 2016; Raes, Schellens, De Wever, & Benoit, 2016; van Leeuwen, Janssen, Erkens, & Brekelmans, 2015; Winne, 2015), which is primarily focused on developing skills of self-regulation (Grau & Whitebread, 2012), co-regulation (Chan, 2012) and socially shared regulation (De Backer, Van Keer, & Valcke, 2014; Isohatala, Jarvenoja, & Jarvela, 2017; Jarvela & Hadwin, 2015; Malmberg, Jarvela, Jarvenoja, & Panadero, 2015), but it seems little attention is paid to the problem of *guessing* regulation.

To achieve our research aim, we tested two control groups of students: lower level students and higher level students. They were given a set of clicker questions, increasing in difficulty and involving both lower-order thinking skills (LOTS) and higher-order thinking skills (HOTS). During the tests, all the students were encouraged to collaborate. However, some of them were announced the penalty for guessing, while the others had no penalty. In addition, the students were given bonus points for answering the clicker questions correctly, so they had an incentive to take the questions seriously.

This paper is organised as follows. Section 2 presents the hypotheses and the proposed research models. It also describes the tests, participants, and procedure used to support the present research. Section 3 reveals the results of descriptive statistics in support of the hypotheses. Section 4 summarises the findings of this study and answers the raised research question.

2. Method and materials

This section discusses the hypotheses formulated to examine the research question and the research models created to visually represent the logic behind the hypotheses. Then, we provide a description of tests, participants, and procedure used to support the present research.

2.1. Hypotheses

To answer the research question, stated in Section 1, we first consider the relationship between the order of thinking skills and the degree of guessing. We hypothesize: