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Learning at distance: Effects of interaction traces on academic achievement

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ABSTRACT

Contemporary literature on online and distance education almost unequivocally argues for the importance of interactions in online learning settings. Nevertheless, the relationship between different types of interactions and learning outcomes is rather complex. Analyzing 204 offerings of 29 courses, over the period of six years, this study aimed at expanding the current understanding of the nature of this relationship. Specifically, with the use of trace data about interactions and utilizing the multilevel linear mixed modeling techniques, the study examined whether frequency and duration of student–student, student–instructor, student–system, and student–content interactions had an effect of learning outcomes, measured as final course grades. The findings show that the time spent on *student–system* interactions had a consistent and positive effect on the learning outcome, while the quantity of *student–content* interactions was negatively associated with the final course grades. The study also showed the importance of the educational level and the context of individual courses for the interaction types supported. Our findings further confirmed the potential of the use of trace data and learning analytics for studying learning and teaching in online settings. However, further research should account for various qualitative aspects of the interactions used while learning, different pedagogical/media features, as well as for the course design and delivery conditions in order to better explain the association between interaction types and the learning achievement. Finally, the results might imply the need for the development of the institutional and program-level strategies for learning and teaching that would promote effective pedagogical approaches to designing and guiding interactions in online and distance learning settings.

1. Introduction

With the development of technology, distance and online education provides a wide spectrum of interactive learning opportunities (Bernard et al., 2009; Bouhnik & Marcus, 2006; Donnelly, 2010; Woo & Reeves, 2007). Over the past few

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decades, interaction – as a main component of distance and online learning – has been studied by various researchers (e.g., Anderson, 2003; Arbaugh & Benbunan-Fich, 2007; Bernard et al. 2004; Wagner, 1994), commonly using Moore's (1989) framework of interactions (e.g., Agudo-Peregrina, Iglesias-Pradas, Conde-González, & Hernández-García, 2014; Anderson, 2003; Kanuka, 2011). According to those considerations, learning occurs when a student *interacts* with other students or with an environment regardless of a subject domain, instructional design or the technology used in the learning process (Tirri & Kuusisto, 2013). Many researchers consider interaction as the most important component of any learning environment (Woo & Reeves, 2007), and thus, importance of interactions in both traditional (e.g., Tirri & Kuusisto, 2013; Mehan, 1998; Johnson, 1981; Yee, 1971) and distance and online educational settings (e.g., Anderson, 2003; Bernard et al. 2009; Hirumi, 2002; Lou, Bernard, & Abrami, 2006; Moore, 1989; Muirhead & Juwah, 2005; Wagner, 1994; Woo & Reeves, 2007) have been studied for a long period of time.

Despite a prevalent understanding of the importance of interaction in online education, research literature does not recognize a unique definition of interaction. Interaction is rather defined from various perspectives, within different contexts, based on the participants involved and the level of their engagement (Bernard et al., 2009; Woo & Reeves, 2007). Wagner (1994) looks at interaction from the functional perspective, as an emerging process that involves communication in various forms. Moreover, she argues that each interaction contains at least two complementary, interrelated, events that occur between two objects. Wagner (1994) also notes that the goal of interaction is to change a student's educational behavior and to bring the student closer to the learning goal. On the other hand, Yacci (2000) defines interactivity as a loop of mutually coherent messages, that should complete the cycle (from and to the student) in order for interaction to occur. The final interaction outcome is either learning of some content or affective benefits. Yacci (2000) further argues for existence of the student-centered perspective to interactivity, which means that students will not confirm the existence of interaction unless they obtain some feedback. Yacci (2000) suggests a communication theory as a valid framework for analyzing online interactions, which includes a wide variety of variables (e.g., the count and length of messages, the type of information and the amount of time spent between two messages) that should be considered when analyzing online interaction. Further, building on the previous definitions of Yacci (2000) and Wagner (1994), Muirhead and Juwah (2005) developed a similar understanding of interaction. According to their definition, interaction represents an event (i.e., communication in any possible form) that occurs between two or more subjects (participants or objects). It might occur synchronously or asynchronously utilizing technology and providing response or feedback as an outcome. Muirhead and Juwah (2005) also recognize the need to differentiate interactions depending on the context in which they occur (e.g., proactive inquiry, reactive inquiry, proactive elaboration).

The majority of the studies that analyzed interactions in online and distance education relied on a perceived measures of interaction (Bernard et al., 2009; Borokhovski, Tamim, Bernard, Abrami, & Sokolovskaya, 2012). While being useful, those measures are not always suitable, especially given the survey fatigue that is well documented in the literature (Ben-Nun, 2008) and the availability of massive amount of trace data logged by various educational platforms (Phillips, Maor, Preston, & Cumming-Potvin, 2012). Therefore, this paper offers insights into how the methods of learning analytics (Siemens & Gašević, 2012) can be used to study effects of interaction on learning in distance and online education. Specifically, the study reported in this paper aims at investigating (i) the extent to which the trace data can be used to measure the interaction types as theorized in contemporary research in distance and online education, (ii) the effects of these measures of the interaction types on learning success; and (iii) whether the effects of interactions types differ across different courses while students are progressing toward their academic degrees (from foundational to core and elective disciplinary courses).

2. Theoretical background and research questions

2.1. Interactions in distance education

The conceptual framework developed by Moore (1989) identifies three types of interactions: i) student–content, ii) student–instructor, and iii) student–student. The student–content interaction type represents the essence of education (Moore, 1989) and identifies the relation that occurs between a student and the content that describes the subject of studying. More recently, researchers and course designers, following the social constructivistic principles, suggest that content is distributed among students and thus, their focus shifts from the student–content interaction type to the student–student interaction type (Anderson, 2003; Moallem, 2003; Woo & Reeves, 2007). The student–instructor interaction type is highly valued, expensive, and least scalable type of communication (Anderson, 2003; Moore, 1989), since it requires instructors' presence and an extensive involvement of the instructor in the course facilitation and direct instruction (Garrison, Anderson, & Archer, 1999). Yet, the development of technology enabled for replacing this type of interaction with student–content interaction type (e.g., by offering more advanced instructional designs or instructional information in different formats such as video and audio) (Anderson, 2003). Finally, the student–student interaction type represents communication between students, without direct involvement of instructors in that communication (Moore, 1989). Johnson (1981) recognizes the student–student interaction type as a crucial component of healthy, socially developed community. He also argues that interaction between peers is essential for maximizing learning outcomes. For example, Schrire (2006) showed that graduate students reach higher levels of knowledge construction and learning outcomes in student–student discussions than in instructor-centered discussions.