Learner–learner interaction in digital learning environments: what and how are we measuring?

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GENERAL INTRODUCTION

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1.1 Introduction

With the world becoming more and more digitized, the field of education has had no choice but to keep up and set out on a quest to digitalize learning. Digital learning defined as "learning facilitated by technology that gives students some element of control over time, place, path and/or pace" (Georgia Gov., n.d.) has come to change the educational landscape and offer novel educational experiences. In these digital learning experiences, in order to construct knowledge, the learner is to interact with the learning content, the instructor, and with other learners through technology. These technology-mediated interactions, defined as "a dialogue or discourse or event between two or more participants and objects which occurs synchronously and/or asynchronously" (Muirhead & Juwah, 2004, p. 13), substantially differ from interactions within traditional, physically situated learning experiences as they involve separation by space and/or time. These interactions vary in their form and size *across* digital learning environments, depending on whether they occur in fully online or blended/hybrid learning environments, and *within* a digital learning environment, depending on whether they occur, for example, in a massive open online course or a small online course.

Hence, within a single course, the learner–instructor, learner–content, and learner–learner interactions will be determined by a number of variables, such as the course structure, the communication medium/a, the number of learners, etcetera (Moore, 2019). The interactions, the ultimate goal of which is "to inform, to consolidate and to enhance meaning making, as well as deepen students' understanding and mastery of the subject matter" (Juwah, 2006, p.1), in their turn, will affect each other, as the limited rate of one type of interaction will necessitate an increased rate of one of the other two (T. Anderson, 2003). Thus, limited learner–instructor interaction within a course will inevitably increase the distance between "what a student understands about a reality, and the understanding of that same reality by the person or persons charged with helping that student in the development of his or her knowledge" (Moore,

2019, p. 34). Reducing this distance would entail making up for the limited learner–instructor interaction by counterbalancing it with increased learner–learner interaction that is expected to enable learners to negotiate meaning and to construct knowledge (Gunawardena, 1999; Stahl et al., 2006; Stahl et al., 2014). At the same time, the formula "the more learner–learner interaction there is (or is required) in a digital learning environment, the better for the learners and learning" does not work either (e.g., Battalio, 2007). Thus, if "the more, the merrier" does not work, one needs to calculate the optimal amount of learner–learner interaction that would lead to meaning making and knowledge construction within *a* course given the course-specific variables. The calculation of the optimal amount of learner–learner interaction is not possible without an initial understanding of *what* learner–learner interaction is and *how* it is or should be measured.

Yet, even though learner–learner interaction underpins the pedagogy of online education (Juwah, 2006; Stahl et al., 2006), its evaluation still constitutes a critical challenge in educational research (T. Anderson, 2003; Gunawardena, 1999; Gunawardena et al., 2016; De Wever et al., 2006). The research findings on learner–learner interaction are highly contradictory, with the role of learner–learner interaction ranging from being nonexistent or negligible (e.g., Battalio, 2007; Gregori et al., 2018; Jiang et al, 2014; Wise & Cui, 2018c) to being significant (e.g., Joksimović, Gašević, Loughin et al., 2015; Kurucay & Inan, 2017; Lou et al, 2006; Schrire, 2006; Zhang et al., 2017) in maximizing learner achievement in digital learning environments. The contradictory findings that can be found not only across different studies but also within the same study (e.g., Jiang et al, 2014) give rise to many questions. For instance, when in a study (Swan, 2000) the correlations between perceived learner–learner interaction and the value put on discussions on the one hand and perceived learning on the other hand are reported as positive while the correlations between value put on cooperative learning and perceived learning are reported as negative, it makes one wonder whether the students did not perceive to be interacting

during cooperative learning. Or when learners' perception of interaction serves as a better predictor of course satisfaction than their actual measured interaction (Fulford & Zhang, 1993, as cited in Bernard et al., 2009), it raises the question of how distinct the distinction between one's actions and "the meaning particular social actions have for the actors whose actions they are" is (Geertz, 1973, p. 27).

Thus, in the light of all this, the next question that arises is not only whether learner–learner interaction by any other name would still be learner–learner interaction but whether by the same name it might not be different "things" in different studies. If this is the case, then can it explain why learner–learner interaction appears crucial here and trivial there (Rogers et al., 2016)? What might it mean for the interpretation and comparison of research findings on learner–learner interaction and the implications for the role of learner–learner interaction? Will it only limit "our ability to develop strong theories that can propel further development" (Bernard et al., 2009, p. 1264) or will it result in incoherent explanations or interpretations of the role of learner–learner interaction in learning in MOOC environments which in their turn may lead to inconsistent or faulty prescriptions for practice? Thus, the central question guiding this dissertation is: *Learner–learner interaction in digital learning environments: what and how are we measuring?*

1.2 Digital Learning Environments

The term *digital learning* was chosen in this dissertation to refer to "learning mediated by different technological methods of transcending physical and virtual space" (Skrypnyk et al., 2015, p. 84), taking into account that it can serve as an umbrella term (Siemens et al., 2015) for online/web-based learning (e.g., Massive Online Open Courses) and blended learning, the two learning environments in which the studies reported in this dissertation were carried out.

Massive Online Open Courses (MOOCs), as implied by their name, have virtually unlimited number of learners that can be enrolled in a single course

on the one hand and limited instructional guidance available on the other. With these two together, the degree to which an individual learner is able to interact with the course instructor is approaching zero. In contrast to MOOCs, which are "planned learning experiences within nonformal, digital educational settings, used to facilitate learning at scale" (Joksimović, Poquet et al., 2018, p. 46), blended courses constitute a combination of face-to-face instruction and web-based, technology-mediated instruction (Piciano et al., 2014; Skrypnyk et al., 2015). Thus, the amount of available instructional guidance in the web-based, technology-mediated portion of a blended course can virtually equal the amount available in the traditional face-to-face portion. This suggests that although in these two digital learning environments, learning involves learner interactions with other learners, instructors, and content, the different proportions of accessible learner–instructor interaction in the two environments would attach different weights to learner–learner interaction in order to enable learners to negotiate meaning and to construct knowledge.

1.3 Learner–Learner Interaction: The Multidimensionality of the Data

Both in MOOC and blended learning environments as well as in any digital learning environment, learner–learner interaction is the communication between learners within a course (Moore, 1989). It can occur between two learners or between several learners or between several thousand learners as, for example, in massive learning environments. Learner–learner interaction in digital learning environments, irrespective of whether it is defined as communication or dialogue or discourse or event, can be synchronous (e.g., chatting) or asynchronous (e.g., discussion boards, peer reviews/feedback). Each and every instance of learner interaction within a course, that is, who, how, and when a learner interacts with and the "artefacts" of these interactions, are captured by the system or the platform through which the course is delivered. As a result, after each course, the course providers are left with gigantic suitcases full of learner interaction

data, the huge size of which is determined by the second-by-second capture of each and every interaction of a learner within the environment and/or by the number of learners enrolled in a learning environment, such as thousands of learners in a MOOC (Wise & Shaffer, 2015).

As with every new phenomenon, these interactional traces are being preemptively embraced and analyzed in unprecedented volumes. This results in a vast amount of research comprised of either studies that utilize trace data to evaluate a single offering or multiple offerings of a single course or studies that utilize trace data from different courses to, for example, develop predictive models. Such "big data" analysis has been envisaged to bring the newest revolution in the field of research on learning by allowing the data to "speak for themselves" and putting an end to theory formation and use (C. Anderson, 2008). However, it is argued that big data "do not, by virtue of their size, inherently possess answers to interesting questions" (Reich, 2015, p. 34), and without a theoretical framework the sound they produce when speaking becomes noise as "when the number of data points is so large something will always be significant" (Wise & Shaffer, 2015, p. 6). The debate of whether we should put the data cart before the theoretical horse or vice versa has been around for some time now (Knight & Buckingham Shum, 2017). We do not intend to reignite this debate; instead, we believe that, whatever the approach, whether data-driven or theory driven, understanding and evaluating the role of learner–learner interaction in digital learning environments is not possible without, first, understanding *what* research measures when it reports to be measuring learner–learner interaction. This initial understanding is crucial as the assumptions about of *what it is* determine *how it is assessed* (Knight & Buckingham Shum, 2017). This understanding of the *what* and *how* will help not to fall into the trap that many research efforts have either by collecting data "that are the easiest to collect, not necessarily the most relevant ones" (Fischer, 2014, p. 150), or by analyzing thousands and thousands of learner trace logs just to re-establish the already established relationship between learner effort

and achievement (Reich, 2015), or by drawing inappropriate conclusions (Wise & Shaffer, 2015).

Learner interaction data captured within digital learning environments in general are multidimensional, with each interactional event "having an author, the contents of the event (a message, action, or command), a time, and an audience: a location, group, or person (a recipient)" (Welser et al., 2008, p. 120). This multidimensionality of learner interaction data "shapes" the approaches that research takes to the measurement of learner–learner interaction, which, in their turn, "shape" learner–learner interaction. Thus, the measurement of learner–learner interaction within a single course can constitute, for example, an analysis of the number of times a learner interacts within the course, an analysis of the structure of learner interactions, an analysis of the text generated through interactions, and/or an analysis of learner self-reported data. To complicate things further, in each case, learner–learner interaction can and will take different shapes, for example, the shape of "the number of posts a learner contributed", the shape of "an entire network", the shape of "the topics discussed", the shape of "group learning", etcetera. This suggests that when two research studies report their findings on the role of learner–learner within a learning environment, they in fact might be talking about different "things". To make things even more complicated, these different things might be combined within a single study and even come into conflict with each other (e.g., Fulford & Zhang, 1993, as cited in Bernard et al., 2009). Given this variability in the measurement of learner–learner interaction, in Chapter 2, we review how a key variable underpinning MOOC pedagogy—learner–learner interaction—is measured in research on MOOCs.

1.4 Learner–Learner Interaction: The Multifacetedness of the Construct

Taking into account the multidimensionality of learner–learner interaction data on the one hand and the approaches that research takes to the measurement

of learner–learner interaction on the other hand, it is sensible to ask ourselves whether with the shapes/measures capturing the different aspects of the construct of learner–learner interaction, narrowing the analysis of learner–learner interaction down to any of the shapes/measures would not mean failing to see the complete picture. To answer this question, it is necessary to understand whether the shapes/measures of learner–learner interaction data are mutually related and if yes, whether the relationships are straightforward. For instance, when the number of posts viewed /posted in course forums (e.g., Coetzee et al., 2014) and learner connections to other learners in a learning network (e.g., Russo & Koesten, 2005) show positive correlations with learner course performance, does this suggest that the more a learner interacts, the better for their learning? That is to say, will the stimulation of the social aspect of learner–learner interaction, as reflected in the counts or the structure of learner–learner interactions (Joksimović, Poquet et al., 2018), per se generate higher-order cognitive processing, reflected for example in the content of learner–learner interactions? If yes, then why do we observe radical, widespread declines in forum participation over time (e.g., Brinton et al., 2014)? Is this because, contrary to expectations, the social does not guarantee the cognitive (e.g., Armellini & De Stefani, 2016; Lockhorst et al., 2002), suggesting that the relationships between the shapes capturing the different aspects of learner–learner interaction are not straightforward? Furthermore, when contrary to our expectations, interactive discussion behaviors become a significant predictor of learning gains only for learners who post less (Wang et al., 2015), does not this imply that the roles that the social and cognitive aspects play in learning might be contingent upon one another (Stodel et al., 2006)?

All these questions that we are obliged to ask suggest that defining and analyzing learner–learner interaction by separating its social and cognitive aspects, examining these in isolation, or narrowing the analysis down to any of the two, leaving out the other, means neglecting the multifaceted nature of the construct reflected in the multidimensionality of learner–learner interaction

data. At the same time, understanding learner–learner interaction and its role in learning in digital learning environments is impossible not only without addressing both the cognitive and the social aspects of the construct but also without examining how these two interrelate. For this reason, Chapters 3 and 4 not only examine the cognitive and social aspects of learner–learner interaction but also explore the nature of the relationship between the two through analyzing how the two interact in predicting learner performance in blended learning and MOOC environments.

1.5 Organization of the Dissertation

This dissertation contains five chapters. While Chapters 2 and 4 focus on learner–learner interaction in MOOC environments, Chapter 3 focuses on learner–learner interaction in a blended learning environment. Chapter 2 provides a review of how learner–learner interaction is measured in research on MOOCs. In Chapters 3 and 4, learner–learner interaction is analyzed by first exploring the cognitive and social aspects of learner–learner interaction and then exploring how the two aspects interact in learning in blended learning and MOOC environments, respectively. To answer the research questions (Table 1.1), the studies included in this dissertation analyze different types of data and employ a variety of methodologies for the analyses.

Chapter 2 presents a selection of studies on MOOCs in order to get an overview of *what* research on MOOCs is measuring when it reports to be measuring learner–learner interaction and *how* it is measuring it. First, we will categorize the types of data that are collected for the measurement of learner–learner interaction in research on MOOCs. Next, we will classify the approaches to the measurement of learner–learner interaction. The variability, manifested both at the type-of-data and approach-to-measurement levels, will be discussed to provide further insights into its implications for the interpretation, evaluation, and comparison of research findings on learner–learner interaction in MOOCs.

Table 1.1

Overview of the Studies Included in the Dissertation

	Digital learning environment	Research questions	Participants	Data
Ch 2	MOOCs	(1) What types of data are collected/used for the measurement of learner–learner interaction in MOOC research? (2) How MOOC research approaches the measurement of learner–learner interaction based on the types of data collected/used?	135 studies on MOOCs	Studies on MOOCs
Ch 3	Blended learning environment	(1) What levels of cognitive presence characterize co-construction of knowledge in online discussion forums in communities of student teachers? (2) How do different levels of individual cognitive presence and learner prominence measures interact in their influence on academic performance?	51 learners	Trace data (Messages posted to discussion threads)
Ch 4	MOOC learning environment	(1) What levels of cognitive engagement characterize co-construction of knowledge in MOOC discussion forum? (2) How do learner interactions and different levels of individual cognitive engagement interact in their influence on learner MOOC performance?	633 learners	Trace data (Messages posted to discussion threads) Questionnaire data

Chapter 3 describes a study investigating the complex relationship between the cognitive and social aspects of learner–learner interaction and their influence on learner academic performance in blended learning environments. First, the content of learner–learner interaction will be analyzed through the analysis of the text contributed by learners in the course discussion forum. In the analysis, we will take a thick description approach and will identify the levels of learners' cognitive presence, reflected in the content of learner–learner interaction, in order to examine how the levels of learner cognitive presence associate with learners' academic performance. Next, taking a structural description approach, we will analyze the structure of learner–learner interaction through social network analysis to determine learner prominence—the outgoing and incoming connections of a learner—within their learning network. Finally, the moderating role of learner prominence measures in the relationship between the learner cognitive presence and academic performance will be examined.

Chapter 4 readdresses the relationship between the cognitive and social aspects of learner–learner interaction in their influence on learner performance, but this time in a massive learning environment, in order to shed light on the dynamics through which MOOCs can support individual learning. The study will first take a thick description approach to the analysis of the content of learner–learner interaction and examine the cognitive levels of learner contributions to the MOOC discussion forum. This will be followed by the analysis of how the cognitive aspect and the social aspect, measured by the total number of different threads a learner contributed to, affect each other in predicting learner MOOC performance.

Finally, **Chapter 5** concludes this dissertation by discussing the main research findings of the three studies. The research findings are discussed from a theoretical and methodological point of view. The chapter concludes with implications for educational research and practice and suggestions for future research.