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The impact of study load on the dynamics of longitudinal email communications among students

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ABSTRACT

With the advent of information technology, emails have gained wide acceptability among students as an asynchronous communication tool. According to the current pedagogy literature the overall trend of the use of email communication by university students has been increasing significantly since its inception, despite the rapid growth of the popularity and acceptability of other social mediums (e.g. Mobile phone and Facebook). In this study, we explore a longitudinal email communication network, which evolved under an increasing study load among 38 students throughout a university semester, using measures of social network analysis (SNA) and exponential random graph (ERG) models. This longitudinal network was divided into three *waves*, where each *wave* represents the portion of the complete longitudinal network that evolves between two consecutive observations. An increased study load was imposed through the assessment components of the course. SNA measures of *degree centrality* (i.e. the activity of an actor or actor popularity), *betweenness centrality* (i.e. the capacity to control the flow of information in a network), *closeness centrality* (i.e. reachable to other nodes) and *reciprocity* (i.e. tendency to make reciprocal links) are considered to explore this longitudinal network. ERG models are probabilistic models that are presented by locally determined explanatory variables and can effectively identify structural properties of networks. From the analysis of this email communication network, we notice that students' network positions and behaviours change with the changes in their study load. In particular, we find that (i) students make an increased number of email communications with the increase of study load; (ii) the email communication network become sparse with the increase of study load; and (iii) the *2-star* parameter (a subset of three nodes in which one node is connected to each of the other two nodes) and the *triangle* parameter (a subset of three nodes in which each node is connected to the other two nodes) can effectively explain the formation of network in *wave3*; whereas, the *3-star* parameter (a subset of four nodes in which one node is connected to each of other three nodes) can effectively explain the formation of network in *wave1* and *wave2*. Interpretations of these findings for the monitoring of student behaviour in online learning environments, as well as the implications for the design of assessment and the use of asynchronous tools are discussed in this paper.

1. Introduction

Instructors of online learning environments often only see students' final products and miss the ongoing communication processes that occur between students during the course (Race, 2001). The ability to collect data that informs us about the processes of communication and

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collaboration, as well as the analytic techniques to apply to such data have both expanded over the last five to ten years (Dillenbourg, Järvelä, & Fischer, 2009; Goodyear, Jones, & Thompson, 2014; Hakkarainen, Lipponen, & Järvelä, 2013; Reimann, 2009; Stahl, Koschmann, & Suthers, 2006). Suggestions for methods of analysing processes that show changes in the dynamics of groups have primarily focused on coded data (e.g. Kapur, 2011; Kennedy-Clark & Thompson, 2013; Reimann, 2009) and transferability to real-time feedback to teachers has been limited. In this paper, we present the results of a three-stage analysis of email communication between postgraduate students during a 13-week course. While the information we have about the *learning* is limited, the potential of the method to inform teachers of student progress is evident. The first section will provide an overview of methods of analysing collaborative learning, followed by a longer section outlining the methods used in this paper. The case study will then be outlined, followed by the discussion including an overview of the implications of this method for future work.

2. Background literature

Collaborative learning has been defined as those situations in which the group is expected to "complete the task together through dialogue and joint action" (Goodyear et al., 2014). Working in collaborative settings is increasingly important for both learning and preparation for future workspaces (Dillenbourg et al., 2011). Computer-supported collaborative learning (CSCL) is a situation in which computer technology plays a role (Goodyear et al., 2014), and may refer to a piece of hardware (such as a mobile device or interactive whiteboard), software running on a computer (such as a simulation model or virtual world) or tools accessible through a browser (such as online forums or email). A challenge for any instructor in an online or computer supported collaborative environment is to understand the activity undertaken by learners in response to a given task. Such knowledge can allow instructors to detect any problems early and develop interventions. Without it, instructors may find it challenging to evaluate collaborative processes, such as the symmetry of participation (Dillenbourg, 1999). Orchestration is a term that has recently been used to describe the processes involved in teaching in CSCL environments. Building on the analogy of the conductor of an orchestra, orchestration in CSCL is the process of productively coordinating supportive interventions across multiple learning activities. Moon (2001) uses 'orchestration' to refer to "the process of managing a whole learning group in such a way as to maintain progress towards the learning outcomes and improvement of practice for all" (p. 120). Orchestration can involve different forms of coordination, including activities at different social, contextual and media levels; scaffolds at different social levels; self-regulation and external regulation; individual motivation and social processes (Dillenbourg & Jermann, 2010; Dillenbourg et al., in press).

Research that examines the *processes* of learning in collaborative settings has developed in the past decade with advances in data collection techniques, and the availability of 'big data' related to the activities of learners (see Goodyear et al., 2014 for a detailed discussion about this). Work in this area has focused on the development of methods of analysis in subject areas such as decision making (Kapur, 2011; Reimann, 2009), knowledge building (van Aalst, 2009), or argumentation (Ding, 2009). Of most relevance to this paper is that which relates to the representation of time and order in analysing processes of learning. Reimann (2009) advocated for event-based analysis that takes into account a group's history when analysing their behaviour. Thompson and Kelly (2012) make a case for a two-stage approach to this kind of analysis, the first using visualisations to determine phases of group work, and then the application of event-based analysis. These authors suggest that this better accounts for the changes in processes of learning over time.

Methods from social network analysis (Wasserman & Faust, 2003) can be applied to computer-supported collaborative learning environments to identify emerging groups (cliques), and (strong) links between participants, and (weak) links between groups – or the lack thereof (Granovetter, 1973, 1983). Other studies have used social network analysis to analyse email communication (e.g. Kazienko, Musial, & Zgrzywa, 2009; Uddin & Jacobson, 2013), examining the node position to determine importance in the network.

Quantitative information about relationships between groups and participants could be helpful for instructors. However, if the quantitative information about students' interactions is only available after the course, instructors may not use this information about students to change their strategies for subsequent cohorts (Tyler, 2011). Presenting information about students' interactions to students after the interaction is finished may be too late to affect group processes. To be able to address emerging problems, instructors need access to carefully selected real-time information (Segedy, Sulcer, & Biswas, 2010). The provision of real-time feedback can be useful for students managing their group work, as well as instructors, needing to know whether and when to intervene. A natural marker of progress through a course is the assessments given, as used in this paper to divide the data collected. Kay, Yacef, and Reimann (2007) developed several representations of interactions between students. They were shown to students after the collaborative task, and students were asked to reflect on whether these represented their understanding of the collaborative processes in their group. One representation developed was a wattle diagram, which showed students' activity in a wiki over time, in terms of work performed and management of group tasks (Kay, Maisonneuve, Yacef, & Reimann, 2006a, 2006b). The analogy of a wattle tree was used, with the main trunk of the tree representing the timeline of student activity (with each day marked), the round yellow flowers represented the wiki-related activity, and orange round flowers represented SVN-related activity. The green leaves represented tickets given to members of the groups, and closed, which indicated the allocation and completion of work. In their analysis, different patterns of activity were identified as the assessment approached. Well organised groups had several, small 'leaves' (tasks allocated and closed), between which were the yellow and orange flowers (activity), evenly spaced. Those groups who worked inefficiently, with most work completed during the week when the task was due to be submitted, had a different pattern observed in their wattle diagram. When examined in combination with other interaction diagrams, they were able to gain insight into roles that were adopted in groups, as well as identify social loafers (Kay et al., 2006a, 2006b).

Email has been used for more than a decade as the official means of communication between instructors and students, as well as between students, in university settings. There are few studies that examine student-to-student interactions (the focus of this paper), most studies concentrate on instructor–student interactions. Research into student satisfaction with instructor's use of email found that students felt that it increased their access to instructors and improved these interactions (e.g. Atamian & DeMoville, 1998; Boles, 1999; Hassini, 2006). In a context analysis of 385 email messages from 42 students, Hassini (2006), found that 33% (the largest proportion) were related to the assignments, followed by the project in which students were expected to participate (26%), followed by grades (21%). Tolmie and Boyle (2000) suggested that asynchronous email exchange facilitated discussion between students, which was seen to be beneficial. Similar to Hassini's (2006), they found that email was used mostly for exchanging drafts of assignments, as well as updating team members on group