Group Informatics: A Multi-Domain Perspective on the Development of Teaching Analytics

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Online Learning

In this position paper, I argue that the separation of learning analytics, teaching analytics and other mechanisms for viewing the relationship between electronic trace data and performance will be enhanced by a perspective that takes related work in other domains into account. I present a few examples from domains I have developed statistical and visual analytics for as exemplars of how a research program might accomplish the fluid transfer of analytics research across domains in a way that impacts teaching and learning. I begin by characterizing some of the limitations I see in learning analytics generally, and which I argue remain salient issues in the development of teaching analytics. In both cases, the goal is to advance learning.

Prior research measuring "online learning" performance has a number of limitations and inconsistencies. First, prior studies of online learning groups do not relate the temporality of group development as a central aspect of analysis, yet group performance, structure and identity are widely understood to change over time (Gersick, 1988; Knowles & Knowles, 1955; Tuckman, 1965). Second, learning performance is not consistently measured or is not measured at all. Student grades are frequently used as a method of convenience, but their limited utility as a measure for learning performance is well documented. Third, there is wide variation in the meaning of words like "online" and "computer supported collaborative learning". In some studies online groups are those who meet partially online and partially face to face (Cho, Gay, Davidson, & Ingraffea, 2007; Cress, Barquero, Buder, & Hesse, 2005; Johnson, Suriya, Yoon, Berrett, & Jason, 2002; Michinov & Michinov, 2007; Michinov & Michinov, 2008; Michinov, Michinov, & Toczek-Capelle, 2004) and in other studies the groups may actually be composed of geographically distributed subgroups (Cadima, Ferreira, Monguet, & Ojeda, 2010). Only a few studies look explicitly at the completely online case (Goggins, Laffey, & Galyen, 2009). Such differences in socio-technical context are widely understood to have a material effect on group experience (Dourish, 2004; Nardi, 2010), but careful comparison and definition of context are missing from the literature. To build inquiry around teaching analytics, these same limitations must be overcome.

I view teaching analytics as a mechanism for improving teaching; which exists as an important profession in society because it serves the purpose of facilitating learning. How teaching analytics improves learning is therefore inseparable from the measurement of learning, and online teaching contexts are of growing importance in societies around the globe. One measure of online learning performance, particularly in groups, is group efficacy. Self-efficacy is a demonstrated predictor of individual performance (Bandura, 1997), and recent research has extended the concept of efficacy to the small group unit of analysis. Hardin, Fuller & Valacich (2006) developed a four-item online group efficacy survey based on the prior work of Whiteoak et al (2004) and Gibson et al (2000). The results of their study included the determination that, in virtual settings, group efficacy is strongly related to group performance. Hardin et al's (2006) survey of group efficacy in an online course is thus one suitable indicator of performance at the group level. Systematic evaluation and comparison of group work products, which Hardin et al (2006) demonstrated to vary with Group Efficacy will serve as an essential performance measure in the work under way. Teaching analytics that focus on the small group unit of analysis, and work to develop the sense of group efficacy within these groups are one important area for focus.

To develop teaching analytics as an area of inquiry, I suggest that we must step back and consider the challenges and opportunities of analytics research across a range of discourse communities. There are four important challenges for leveraging electronic trace data for the development of analytics in any domain. First, the electronic trace data alone is not usually a complete record of participant interactions (Goggins, Mascaro, & Valetto, 2012b; Goggins, Valetto, Mascaro, & Blincoe, 2012a; Howison, Wiggins, & Crowston, 2012). Second, the relationship between these traces and performance requires systematic evaluation (Adar & Ré, 2007); third, organizational flexibility as measured through the change in the social networks detectable from electronic trace data is difficult to ground both theoretically and empirically solely in analysis of those traces (Goggins et al., 2012b; Howison et al., 2012). Fourth, leadership in virtual organizations can be captured through social network analysis of electronic trace data, but how these networks relate to structural change and performance varies significantly across contexts (Blincoe, Valetto, & Goggins, 2012; Cataldo, Wagstrom, Herbsleb, & Carley, 2006; Goggins et al., 2012b; Goggins, Laffey, & Amelung, 2011; Goggins, Laffey, Amelung, & Gallagher, 2010; Goggins, Mascaro, & Mascaro, 2012; Gong, Teng, Livne, & Brunetti…, 2011; Huffaker, Teng, Simmons, Gong, & Adamic, 2011; King, 2011; Mascaro & Goggins, 2011a). New methodological approaches to technology mediated learning and teaching analytics research, both empirical and theoretical, are required to address these challenges.

The rest of my position paper is broken down into two sections. First, I provide a review of prior approaches to the analysis of electronic trace data across domains. Second, I present a brief overview of my Group Informatics methodological approach (Goggins et al., 2012a; Goggins et al., 2012b).

Theoretical Background and Approach

Electronic Trace Data for Socio-Technical Analysis and Measurement

The non-teaching and learning environments I discuss frame the discourse on teaching analytics in a larger context, and bring an important perspective to the goals of the workshop. Previous research leveraging large scale electronic trace data has used a variety of approaches. Golbeck et.al (2010) analyzed Twitter use by the US Congress to identify how elected officials were using the technology. Sense-making has been used to understand how Twitter facilitates information sharing in a crisis situation (Heverin & Zach, 2011). In this study, content and discourse analysis along with a time-series analysis were used to analyze the frequency of messages over time, but there was limited identification of important actors as part of the network. Other research uses algorithmic approaches to understand sentiment and trends in social media (Jansen, Zhang, Sobel, & Chowdury, 2009; Naaman, Becker, & Gravano, 2011; Thelwall, Buckley, & Paltoglou, 2011a; Thelwall, Buckley, & Paltoglou, 2011b). Examining sentiment using text analysis tools, without qualitative analysis of the content in this communication or analysis of the social networks that emerge and change through technology severely limits and even distorts the findings and potential contribution of these studies, and others like them (Back, Küfner, & Egloff, 2010; Back, Küfner, & Egloff, 2011; Pury, 2011). Network analysis is one important tool that Group Informatics adapts to represent emergent social phenomena, especially within groups that emerge in technology mediated environments.

Network analysis of technologically-mediated groups leverages knowledge from decades of social science research focused on understanding how social interactions between individuals evolve into social networks, and how these networks influence individual and group behavior (Freeman, 2003; Freeman, 2004; Straus, 1993). Through decades of research on thousands of datasets describing interactions in the physical world, network analysts built a set of validated measures to help identify important actors in these social networks. Well-known statistical measures of individual influence and network position include betweenness, which identifies bridging individuals who connect two clusters in a network; closeness, which describes the ability of a person to reach information within the network through a set of ties; and degree centrality, which is a measure of an actors overall connectivity to other actors

in the network. These measures have different meanings when viewed through different theoretical lenses and care must be taken to understand the meaning in each application (Freeman, 1979; Friedkin, 1991).

Technology mediated environments are studied as networks (Brown & Duguid, 2000), communities of practice (Wenger, 1998), groups (Goggins, Laffey, & Tsai, 2007; Rohde & Shaffer, 2003; Rohde, Reinecke, Pape, & Janneck, 2004) and individual relationships (Granovetter, 1985). Like Mitchell (Mitchell, 1969), we identify the relationship between these different organizational structures as existing on a continuum that is discernable through comparative studies of social network characteristics, such as density and size.

A New Methodological Approach for Theory Building

My research team and I developed a comprehensive methodological approach and ontology for the study of virtual organizations that addresses the four challenges outlined above (Goggins et al., 2012b). This approach includes the contextualization, aggregation and weighting of member interactions, captured as electronic trace data, with the technical environment producing trace data, artifact categories, characteristics of members and groups and the nature and type of interactions that occur between technology mediated learning environment members. Among the tenets of the Group Informatics approach is the focus on the small group as the unit of analysis, and the integrated, concerted use of quantitative and qualitative methods for that analysis, which leverage electronic trace data produced within virtual organizations. We want to study and develop analytics for a range of virtual organizations at the small group level in response to changes in the role of ICTs in daily life and work. There is a well recognized reflexive relationship between organizational change and ICT uptake and use (Kling & Scacchi, 1982; Kling, 1979; Kling, 1980; Kiesler, Boh, Ren, & Weisband, 2005), but the shift in ICT use from systematic, work-focused use to wide, diffuse use in daily life (Grudin, 2010; Sawyer, 2009) calls for a reconsideration of the role that small group's, who form or emerge within technology mediated organizations, play in adoption of ICT, and their impact on structural change and performance. Further motivation for this shift is supported by long-standing analysis of social behavior that recognizes the central role small groups play in organizational change, societal change (Fine & Harrington, 2004) and ICT adoption and use (Goggins, Laffey, & Gallagher, 2011; Mead, 1934; Mead, 1958; Stahl, 2006). In the past, the munificent variation of what constitutes a group inspired calls for abandonment of "group" as a construct for collaborative computing research (Schmidt & Bannon, 1992), yet important theory development related to ICT mediated groups contained in larger organizational contexts continued as a relatively small thread within information science and CSCW research

(Latour, 2007; Turner, Bowker, Gasser, & Zacklad, 2006). The theory development we propose recognizes these tensions between units of analysis in the field.

Group Informatics is principally concerned with the emergence and development of small groups within larger socio-technical environments, which may be conceptualized as communities of practice, networks of practice or, more broadly as virtual organizations. In the Group Informatics model, individual relationships are implicit in the occurrence of an interaction between two people, made visible via electronic trace data.

The types of collaboration and emergence we study are easily conflated with a milieu of socio-technical community, group and organizational forms often discussed in broad strokes while presenting data focused on a singular example. A few articles have deliberately advanced less specific descriptions of group size in favor of a broad consideration of collaboration through technology (Schmidt & Bannon, 1992). When looking across different socio-technical systems, more care must be taken with the use of these terms. There are important differences between studies of popular social networking sites, collaborative wikis, and what we mean by technology mediated environments. Social networking sites like Facebook and MySpace make a person's ego network more visible, encourage the development and maintenance of weak ties (Granovetter, 1985), and do little to support group work or group identity, though many people do join particular online groups as an expression of identity. In these settings, groupness is less a phenomenon that emerges from discourse or work, but is instead predetermined by identity formed outside the environment (Goggins & Mascaro, 2012; Goggins et al., 2012a; Mascaro & Goggins, 2011a; Mascaro & Goggins, 2011b). In the social networking sense, the use of Facebook for social coordination constitutes what Brown and Duguid characterize as networks of practice (Brown & Duguid, 2000). Networks are more loosely configured than "communities", but in general are a more apt description for these phenomena.

Present day collaborative editing systems invert those same limitations. Studies of Wikipedia demonstrate the interjection of individual effort into a collaborative virtual knowledge space that is heavily controlled by member practices (Kittur & Kraut, 2008; Priedhorsky et al., 2007) and systematic bureaucracy (Kittur, Suh, Pendleton, & Chi, 2007). In Facebook, members are locked into an ego-centered interaction, whereas in Wikipedia, users are locked into an artifact-centered interaction. Neither system makes fluid movement between the people working on the system and the artifact possible. Notions of coherent, emergent groups are designed out of each system and the trace data these systems produce reflect these orthogonal, but equally narrow types of social interaction. User modeling and personalization complements this work through its focus on designing for the user. Integration of research focused on the limitations of artifact focus, social interaction

focus and user modeling and personalization is therefore an especially promising, synthesized area of inquiry. One could argue that the similarities between wiki governance and a traditional classroom are striking.

The interaction is central to Group Informatics, and is captured between people, or people and artifacts; which are treated as boundary objects (Lee, 2007; Star & Griesemer, 1989) around which interactions occur. The contribution to the workshop that I propose leverages my methodological approach to measure structural change between teachers and students in technologically mediated learning environments by contextualizing their interactions and roles; and operationalizing Dourish's (2004) view of context as a dynamic construct in the service of developing teaching analytics as a new and important area of inquiry.

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