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Web-Based Learning as a Social Process: A Critical Examination of the Research

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Research related to Web-based learning (WBL) has grown exponentially in the last decade. Scholars have explored a variety of areas related to WBL, including techniques, strategies and best practices. One area of particular interest to scholars is the potential of WBL to support and facilitative collaborative learning. Despite the continued exploration, there continues to be a concern related to the theoretical foundations of WBL. The purpose of this article is to explore how different theories may be used to guide research and inform practice in online collaborative learning. We integrate the major points drawn from current research and theory from a variety of perspectives so as to gain a better understanding of how learning is enabled by asynchronous modes of online collaborative learning. We then use this understanding to identify opportunities and challenges for theory development and research in WBL.

Keywords : web-based learning (WBL), social process, Critical examination

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Substantial work has taken place in the area of Web-based learning (WBL) during the last decade. Significant strides have been made in many areas related to WBL: pedagogical strategies, learning techniques and even with the very technology used to implement WBL. Concerns have been raised, however, related to research in this area (Anglin & Morris, 2002; Berge & Morozowski, 2001; Fabos & Young, 1999; Hannafin & Kim, 2003; Reeves, 2003). Apprehensions have ranged from a lack of agreement related to best practices for teaching to a lack of agreement regarding the best learning theories for WBL. Collectively, researchers have indicated the lack of a compelling theoretical foundation from which to derive research in WBL.

Some researchers have made suggestions to try to overcome some of the theoretical challenges. Miller and Miller (2000), for example, recommended that practitioners of WBL have a strong theoretical foundation to guide their work, stressing that it is more important to be able to articulate why a particular theory was selected rather than worrying about the "correct" theory. However, the lack of agreement related to a set of "best theories" can make this challenging.

Others may argue that a "best theory" (or theories) for WBL is not necessary. Since this kind of learning was not available prior to the last decade, the authors of this paper have concluded it is critical to understand and describe the unique characteristics of WBL and how that impacts the use of existing theories. If we apply existing theories to the practice of WBL with the anticipation that similar levels of effectiveness may be realized, we may be setting ourselves up for disappointment.

Some researchers have worked to gain an understanding of WBL theory. For example, Laurillard (2002) has promoted the idea that the communicative media available on the Web can be a lens for establishing theory. Laurillard describes the media as having the specific task of bringing people together to discuss ideas and ask questions. The resulting interaction may be between instructor(s) and student(s), or between students, creating a 'Conversational Framework' (i.e., learning process as an iterative conversation).

Other researchers have started to explore specific affordances associated with WBL and how that might influence the development of WBL theories. Online collaborative learning is one such area. Collaborative learning refers to a process of social construction of knowledge situated in community of inquiry (Bruffee, 1999; Harasim, 2002; Islas, 2004). Knowledge is not something that is delivered to the learner, but rather emerges from active interaction among individuals who seek to understand and apply concepts and skills. According to some researchers, the social construction of knowledge in WBL leads to deeper processing and understanding than does learning individually (e.g., Bonk & Cunningham, 1998; Sorensen, 2004).

There appears to be a consensus among theorists, researchers, and practitioners that collaborative learning can be successfully enabled by Web communication tools (see Bannan-Ritland, 2002, and Hill, Wiley, Nelson & Han, 2003, for a review of the research). Researchers and scholars have suggested Web-based collaborative learning enables in-depth collaboration, consequently enhancing social interactions amongst students and providing opportunities for co-construction of knowledge, with or without face-to-face meetings (de Jong, Veldhuis-Diermanse, & Lutgens, 2002; Kirschner, Martens, & Strijbos, 2004; Reeves, Herrington, & Oliver, 2004).

Researchers have also designated areas of difficulty related to online collaborative learning (Järvelä & Häkkinen, 2003). Researchers indicated collaborative processes are over emphasized and generalized. Further, the Web-specific features associated with the collaborative processes are not explicated (Roschelle & Pea, 1999). There has been discussion in the literature specifically questioning whether asynchronous online collaborative learning enables learners to create meaningful interaction and enable group processes (Alavi & Duftner, 2005; Roschelle & Pea, 1999).

The purpose of this article is to explore how collaborative learning is described and examined in recent WBL studies, especially in studies examining the use of asynchronous discussion. The article explores how different theories may be used to guide research and inform practice in online collaborative learning. We seek to integrate the major points drawn from current research and theory from a variety of

perspectives so as to gain a better understanding of how learning is enabled by asynchronous modes of online collaborative learning. We begin our discussion with a conceptualization of WBL as a social process from divergent perspectives (e.g., communication, learning). We then use this understanding to identify opportunities and challenges for theory development and research in WBL.

Understanding WBL as a Social Process

A review of the literature indicates that the essence of collaborative learning is convergence. That is, learning is a gradual convergence enabled through communicative knowledge (mutual understanding and social knowledge) and construction of shared knowledge (Brown & Palinscar, 1989; Bruffee, 1999; Cranton, 1996; Rochelle, 1992). Accordingly, individual contributions converge and over time, the group approaches general agreement related to a topic or point of conversation. In this context, collective intelligence is a viable consequence of learning (Bruffee, 1999; Smith, 1994). With this as a foundation, further exploration of the foundations of WBL can be undertaken.

Foundations of WBL as a Social Process: Constructivist Learning Theories

Learning theories work to specify the conditions under which learning is enabled or hindered (Perraton, 2000). While there is not general agreement related to the "best" learning theory, several research and development activities for WBL environments have relied on the underlying theories of constructivism (e.g., Topping & Ehly, 1998; Tudge & Rogoff, 1989). We provide a brief review of constructivist learning theories to establish an underlying understanding of collaborative learning from two perspectives: neo-Piagetian perspective and Vygotskian Perspective.

Reconciling Cognitive Conflicts through Collaboration: A Neo-Piagetian Perspective

According to Piaget, learners think and acquire knowledge through their actions and successful actions precede conceptual understanding in their learning. From a Piagetian perspective, a learning environment should be designed to facilitate individual learners to initiate and complete their own activities, leading them to meaning making, problem discovery, and problem resolution (Driscoll, 2000; Lisi & Golbeck, 1999). Piaget believed that peer interactions are essential in helping learners move beyond egocentric thoughts (Driscoll, 2000).

Learning through interaction with peers, however, does not guarantee that the learners in the group share the same level of understanding. An individual learner brings important value to the group that enhances the quality of learning and level of understanding (Lisi & Golbeck, 1999; Toppig & Ehly, 1998). However, cognitive conflict can arise when there is a perceived contradiction between the learner's existing understandings and what the learner experiences in the course of interacting with others (Lisi & Golbeck, 1999; Topping & Ehly, 1998). Cognitive development, as defined by Piaget, is a process where the learners reconcile their cognitive conflict as expressed by their different points of views (Forman & Cazden, 1985; Gilly, 1990). It is this process that allows learners to infer meaning through collaborative learning even in a context of conflict.

Advancing Collaboration through Zones of Proximal Development: A Vygotskian Perspective

According to Vygotsky (1978), collaborative learning, either among learners or between learners and more knowledgeable others, is essential as learners advance through their zone of proximal development (ZPD). ZPD refers to the difference between the learner's ability to engage in independent problem solving under expert guidance or in collaboration with more capable peers (Vygotsky, 1978). Vygotsky moves beyond a focus on the benefits of peer interaction, to the benefits of

interactions with more knowledgeable peers. From a Vygotskian perspective, it is more important for learners to be exposed to a higher level of reasoning than their current level so that ZPD can be explored and confronted (Hogan & Tudge, 1999).

A Vygotskian perspective stresses that learners need to take each other's perspective into account and come to a shared understanding of a problem (Hogan & Tudge, 1999; Wertch, 1985). Individuals bring their unique characteristics to any kind of interaction. These characteristics are socially grounded and also shaped from the individual's personal experience (Vygotsky, 1994). A Vygotskian perspective proposes that knowledge does not preexist, but is socially constructed first and then individually incorporated (Hogan & Tudge, 1999). That is, a sense of collaboration is not just learners simply working together or one person demonstrating solutions to the other; rather, learners are co-constructing the solution to a problem in a mutual decision–making process (Driscoll, 2000).

The Concept of WBL as a Social Process

From the earliest exploration in online education theory and practice, collaborative learning has been suggested to be a robust principle of WBL design and implementation. Many WBL applications have been developed based on the theory of collaborative learning (e.g., European Collaborative Learning Network Project, CL-NET, see de Jong et al., 2002; Computer-Supported Intentional Learning Environments, CSILE, see Hakkarainen, Lipponen, & Järvelä, 2002; Knowledge Integration Environment, KIE, see Bell, 2002). The features of Web-based technologies such as multilateral interaction (i.e., many-to-many), multimedia (e.g., text, audio, video), and multiple communication modes (i.e., synchronous and asynchronous) support more dynamic, yet complex interaction among participants. This enables the creation of an environment where participants share cognitive loads, co-create process and products, and come to a shared understanding.

Kahn (1997) defined Web-based instruction (WBI) as "a hypermedia-based instructional program that utilizes the attributes and resources of the Web to create

a meaningful learning environment where learning is fostered and supported" (p. 6). This definition is a way of looking WBI as a "program," including multiple resources and supports for participants in this specific teaching and learning tool. This definition reflects the evolution of Web technologies and its potential as a field of study. In other words, when it supports the teaching and learning process, the greatest potential of a Web-based application is considered as self-contained and a collaborative media.

Harasim (1990) described online education as "an environment for collaboration and intellectual amplification" (p. 39). The notion of learning as a social process has been added to this early definition, and this idea has been extended to 'learning networks' (Harasim, Hiltz, Teles, & Turoff, 1995) and more recently, 'virtual community' in last the decade (Harasim, 2002; Rheingold, 1993). Learning networks and virtual community stem from the use of computer-mediated communication (CMC) in an educational context as a result of combining telecommunication with computer technology and digital networks (Berge & Collins, 1995; Romiszowski & Mason, 2003). CMC in its simplest forms concerns the process of exchanging thought, ideas, and information using a computer with telecommunication technologies. In this notion, a computer network is primarily an agent of communication and learning.

We found the diverse definitions and concepts informative for extending an understanding of WBL. A common idea represented in the definitions is the notion of human interaction in teaching and learning supported by the affordances of the Web. Our understanding of WBL focuses on how collaborative learning supported by Web-mediated technologies can enhance interaction amongst learner, and how collaboration and technology facilitate sharing and distributing of knowledge and expertise among group members (e.g., Koschmann, 1996; Lipponen, 2002).

A brief review of constructivist learning theories as well as multiple perspectives related to diverse concepts related to current understandings of WBL were presented to create a context for exploring the literature. To extend our

understanding of the WBL, it is useful to examine the specific context in which the research occurs. In doing so, we focus on how social processes – interaction and convergence – are supported through Web technologies to understand the nature of the learning process.

Review of Research in WBL: Online Collaborative Learning

Research on online collaborative learning has focused on how *interaction* occurs in a social process. Interaction can be described differently from multiple perspectives (e.g., Anderson, 2003; Bannan-Ritland, 2002). In this paper, interaction is defined as *active involvement in the social process of learning*. The operational definition is primarily focused on interaction amongst participants in WBL, including learners and instructors. The conceptual frameworks related to interaction in WBL can be categorized with three main themes: *types* of interaction, *levels* of interaction, and *patterns* of interaction. Research studies in each category have examined what interaction occurs and how interaction transpires. Table 2.1 summarizes a review of the research in this area. We will describe each category and review the research to date in the following sections.

Types of Interaction

Our operational definition of the type of interaction can be described as the *combinations of actors (e.g., learner, content, instructor) engaged in the interaction*. From a distance education foundation, Moore (1989) identified three different types of interaction: learner-content, learner-instructor, and learner-learner. In brief, learner-content interaction is described as the individual learner's construction of knowledge through the process of complying information into existing cognitive structures. Learner-instructor interaction describes how the instructor's strategies and support assists with the learner's interaction with the course content. Learner-

learner interaction indicates interaction occurring between two or more students without the instructor's presence (Moore & Kearsley, 1996).

Later, with the growth of the Internet technologies, Hillman, Willis, and Gunawardena (1994) presented the idea of "learner-interface interaction." Learner-interface interaction implies that the interface (i.e., technology affordances) contributes to interaction between the learner and content, instructor, and/or other learners. More recently, Anderson (2003) suggested a more comprehensive view of the types of interaction, adding instructor-content, instructor-instructor, and content-content interaction.

Instructor-content interaction relates to the instructional design process from the instructors' perspective. Instructor-instructor interaction establishes a community of instructors enabling the creation of intelligent network of instructors with professionals from multiple disciplines. Content-content interaction is based on an intelligent agent that offers assistance on various subject area in the same and different institutions (Anderson, 2003).

As briefly reviewed, the framework related to the types of interaction has extended with the growth of technology and the complexity of the learning context. The description of each type enables us to understand a range of interactions representing who (or what) interacts with each other in online learning systems.

Some comprehensive reviews of research (e.g., Bannan-Ritland, 2003; Hill et al., 2003) reported that in research examining each type of interaction, the primary concern focuses on human interactions, specifically interactions amongst learners and between the learner(s) and instructor(s). While the framework is useful, it is not readily applicable to specific contexts and types of learning (Anderson, 2003; Hirumi, 2002). Rather, we found this framework useful as an overarching structure that describes examples of interaction. In the examination of a social process of learning, the framework informs us of who to consider as "actors" in the process, including human interaction and the technological affordances.

Levels of Interaction

As mentioned, much of the research to date has focused on human interactions, especially learner–learner interactions. Specifically, researchers have investigated the different levels of interaction amongst learner (Bannan-Ritland, 2003; Hill et al., 2003). Our operational definition of the level of interaction is *the degree of quality and quantity of interaction*. Research in this area is grounded on diverse foundations (e.g., learning theories, communication theories, information systems research). In this article, we focus on reviews of research in regard to how learning theories describe and examine hierarchical levels (i.e., cognitive development) of interaction amongst learners in a social process (see Table 1 for a summary).

From a constructivist learning perspective, Gunawardena, Lowe, and Anderson (1997) proposed five different levels of interaction, including sharing of information, exploration of inconsistency among ideas, negotiation of meaning, modification of proposed synthesis, and applications of newly constructed meaning. The underlying assumption related to the levels of interaction is that the learner moves through five levels as they construct knowledge. Each level includes complex and multiple subsets and the levels of interaction have been used as analysis protocols.

Gunawardena, Lowe, and Anderson (1997) conducted an empirical study on their model, analyzing an online seminar using the theory-based model they developed. The researchers debated online with 554 graduate students for a week, focusing on the topic of computer-mediated communication, such as online interaction. At the conclusion of the debate, they examined the transcripts of the listserv for the seminar to determine whether co-creation of knowledge or negotiation of meaning had occurred through the accumulation of individuals' knowledge. Through their analysis, they illustrated how the levels of interaction were observed in participants' messages on the listserv. Further, they reported the first level (i.e., sharing of information) was the most prevalent type of message in terms of quantity.

Table 1. Summary of the research in an online collaborative learning

Views of interaction	Research Reviewed	Descriptors in the Research	Implications and Considerations
Types of interaction	• Moore (1989); Moore & Kearsley (1996) • Hillman, Willis, Gunawardena (1994) • Anderson (2003)	• Interaction between learner-learner; learner-instructor; learner-content • Learner-interface interaction • Interaction between instructor-content; instructor-instructor; content-content	• Identify *combinations of actors engaged in interaction* • Overarching frameworks for studying interaction • Should examine different types from multiple levels in a social context • Should examine factors associated with implementation
Levels of interaction	Gunawardena, Lowe, & Anderson (1997)	• Constructivist learning theories • Collaborative learning as interaction in a process of mutual knowledge construction • Five levels of knowledge construction: sharing information; exploration of inconsistency among ideas, negotiation of meaning; modification of proposed synthesis; and applications of newly constructed meaning	• Identify *the degree of quality and quantity of interaction* • Explicate the qualitative aspect of interaction as a group cognitive development • Describing how individual message is demonstrate each level • Quantification of results: generally, low level of interaction reported • Should examine intra-message (i.e. how messages are related) effects in a social process
	Kanuka & Anderson (1998)	• Constructivist learning theories • Applied Gunawardena et al. (1997) and Henri (1992) • Newly identified themes: social interchange, social discord	

Järvelä & Häkkinen (2002, 2003)	● Socio-cognitive perspective (e.g., Selman, 1980) ● Collaborative learning as a social interaction and perspective taking ● Five stages of perspective taking: egocentric; subjective role taking; reciprocal perspective taking; societal symbolic perspective taking ● Level of discussion: high-level discussion; progressive discussion
Kang (1998)	● Socio-cultural perspective on learning ● Collaborative learning as a social interaction and mutual construction of knowledge ● Applied Walther (1994, 1996): impersonal, interpersonal, hyperpersonal effects of interaction
Cecez-Kecmanovic & Webb (2000a, b)	● Critical social learning theory ● Collaborative defined as social interaction ● Level of collaborative learning: a linguistic act level (i.e., personal experiences, desires, feeling) and a learner orientation level (orientation to achieving an end, orientation to self-presentation)

	Yang & Tang (2003)	• Social network analysis • Examine effects of social networks (i.e., friendly, advising, adversarial) on student performance	• Identify *an arrangement of interaction in a social context* • Visualization of interaction patterns • Examine effects of size, density, centrality on interaction patterns • Report quantification of the results • Lack of understanding of qualitative aspect of interaction
Patterns of interaction	Beck, Fitzgerald, & Pauksztat (2003)	• Social network analysis (i.e., core-periphery) • Examine the contribution of individual and social factors in the development of communication networks • Describe the density and centrality of the network	
	Fahy, Crawford, & Ally (2001)	• Social network analysis: influence of size, intensity, and the density on interaction patterns • Transcript Analysis Tool (TAT): sentence types (i.e., questions, statements, reflections, engaging comments, and quotation/citation)	

Kanuka and Anderson (1998) applied Gunawardena et al. (1997)'s analysis protocol to observe the social cognitive processes and assess the learning in an online discussion forum in a training setting. Similar to Gunawardena et al. (1997), they also reported most of the messages students generated through the online discussion were at the first level (i.e., sharing information) of interaction. Other data sources (e.g., survey) in their study indicated that participants perceived the online discussion as a "network of information." This helped confirm that the majority of interactions were created on the first level of interaction (i.e., sharing of information).

Other researchers have applied Gunawardena et al. (1997)'s analysis protocol in addition to Kanuka and Anderson (1998) (e.g., Hew & Cheung, 2003; Islas, 2004; Marra, Moore, & Kimczak, 2004). Other studies also indicated that the first level of interaction (i.e., sharing of information) was reflected in the transcripts of asynchronous discussions in WBL. Researchers in these subsequent studies expressed the value of detailing aspects of the interaction at each level, describing the broader framework (i.e., main levels) as useful for analysis of the data. However, challenges in applying the protocols were also expressed, including: unclear boundaries of each level and complexity of the protocols (Fahy, 2001; Kanuka & Anderson, 1998; Marra et al., 2004).

The primary challenge reported in the literature related to the complexity of the subsets of the protocol. Each level in the Gunawardena et al. (1997) protocol includes multiple subsets. For example, negotiation of meaning/co-construction of knowledge, a main construct in the protocol, contained five subsets (negotiation or clarification of the meaning of terms, negotiation of the relative weight to be assigned to types of argument, identification of areas of agreement or overlap among conflicting concepts, proposal and negotiation of new statements embodying compromise co-construction, proposal of integrating or accommodating metaphors or analogies). Overall, the protocol contains a total of 21 constructs. In applying the constructs, researchers reported that the pre-established analytic code does not

enable differentiation of each category in a specific context. While Gunawardena et al. (1997)'s framework provides detailed description on each level based on extensive review of existing models (e.g., Henri, 1992), use of this framework may not allow for a contextual analysis of the construction of knowledge (Kanuka & Anderson, 1998; Marra et al., 2004).

Other researchers have suggested different analysis frameworks. Järvelä and Häkkinen (2002, 2003) investigated different levels of interaction from a socio-cognitive perspective. They analyzed five developmental levels of the coordination of social perspectives taken in online environments:

- Egocentric: Learners present subjective and egocentric opinions and expressions without paying attention to other learner's perspectives.
- Subjective role-taking: The discussion is constituted of a one-way conception of relating perspectives and learner's responses to prior postings are similar.
- Reciprocal perspective taking: Learners recognize a variety of different perspectives; a two-way reciprocity of ideas and expressions is typical.
- Mutual perspective taking: Learners coordinate the perspectives each other, consequently, the topic in discussion is viewed from the third person or mutual perspective.
- Societal-symbolic perspective taking: Discussion moves toward on multidimensional or higher levels of communication; in discussion learners conceptualize multiple mutual perspectives to societal, conventional, legal, or moral perspectives that all the individuals can share.

According to Järvelä and Häkkinen's framework, the higher the level of perspective taking reached, the greater the contribution to learning.

Järvelä and Häkkinen's 2003 study indicated that 36% of the messages were subjective role taking, 36% of the messages were mutual perspective taking, 20% of the messages were reciprocal perspective taking, and 8% of the messages were egocentric. No messages were categorized as societal symbolic perspective. In addition, the researchers also reported that high-level discussion (i.e., theory–based

discussion, 24%) was either in reciprocal perspective taking or mutual perspective taking, and progressive discussion (i.e., jointly knowledge building, 40%) was mainly in reciprocal perspective taking. The results of study indicated that the stage of perspective taking in online discussion was generally rather low regarding to the number of messages generated through the discussion.

Kang (1998), using a socio-cultural perspective on learning (e.g., Lave & Wenger, 1991/2001), conducted research on electronic collaboration in university settings. In her study, she also employed Walther's (1994, 1996) framework on a three–level matrix of the effects of electronic interactions (i.e., impersonal, interpersonal, and hyperpersonal interaction) from communication research foundations. She concluded that online environments provided more opportunities for increasing collaboration and social interaction among participants. During the early stage of the course, technological challenges and lack of social presence confronted students with impersonal effects of interaction, yet, over the semester, students expressed a sense of "closeness" that represents shared concerns and experiences. Moreover, students' comments also revealed hyperpersonal (i.e., instances of connection) relationships and intersubjectivity that evolved over the semester. The researcher emphasized that it is not important whether the effects of interaction is personal or not, but rather the emphasis should be on how to implement and foster students' electronic collaboration.

Cecez-Kecmanovic and Webb (2000a, 2000b), using a critical social learning theory (e.g., Habermas), extended the concept of collaborative learning as social interaction and developed a communicative model of collaborative learning. Within this framework, the researchers investigated linguistic acts of graduate students in a Web-based course in terms of what linguistic acts refer to and how they contribute to the dialogue at the same time. They also explored how linguistic acts contribute to the construction and maintenance of collaborative learning processes. Emphasizing acts of communication in social interaction mechanisms, they categorized the linguistic acts constituting collaborative learning processes in two

levels: linguistic acts and learner orientation. Linguistic acts consisted of the subject matter and the topic of discussion, norms and rules governing the process of collaborative learning, and personal experiences, desires and feelings. Learner orientation included orientation to learning, orientation to achieving an end, and orientation to self-presentation.

The studies by Cecez-Kecmanovic and Webb on levels of interaction proposed detailed and descriptive information on the quality of interaction in WBL. The studies provide a theoretical understanding of the levels of interaction demonstrated in the collaborative learning process. The proposed models reviewed above, are grounded in different research foundations (i.e., constructivist learning theories, communication theories) and present empirical evidence to support that it is important to understand how individuals present their ideas and how meaning is generated through messages in online discussions.

There are several challenges associated with the research related to levels of interaction in online learning. First, how different levels of interaction are influenced or supported as a social process is not yet fully described. It appears that analysis of individual messages is not sufficient to explicate the group process (i.e., convergence). Another challenge is the quantification of results (i.e., numbers of posted messages in each level). Enumerating the number of postings may tell us how much interaction occurred in terms of types of interaction (e.g., learner-learner), but it does not assist us in understanding how collaborative learning occurs. Moreover, how to assess the interaction using the proposed model is not demonstrated. Future study needs to further analyze the complexity of interaction, and what different levels mean in the social process of learning.

Patterns of Interaction

Many researchers have concentrated on analyzing the individual messages in online discussion. Other researchers have explored the patterns of interaction amongst and between messages (Fahy, 2001; Garton, Haythornthwaite, & Wellman,

1999; Turoff, Hiltz, Bieber, Fjermestad, & Rana, 1999). Social network analysis is a method used to describe how patterns of relationships exist among participants, to analyze the structure of these patterns, and to discover what the affects of the interaction are on people and the context (Garton, et al., 1999). Our operational definition of the pattern of interaction is *an arrangement of interaction in a social context.*

Using quantitative methods, Yang and Tang (2003) investigated the effects of social networks (i.e., friendly, advising, and adversarial) on students' performance in WBL comparing it to traditional educational context. Results from their study indicated that advising networks are positively related to student performance both in a traditional class and in WBL. They also reported advising and adversarial networks were good determinants for overall academic performance; however, adversarial networks were not influential on students' performance on the WBL. In fact, adversarial networks were negatively correlated with almost all students' performance in both contexts. Friendship network variables were not correlated to students' performance.

Using a core-periphery social network analysis model, Beck, Fitzgerald, and Pauksztat (2003) examined the social factors in the development of communication networks. They examined preservice teachers' online discussion group which included 32 multiple subject teachers who were given the task of observing, reporting, in writing, activities in their mentor teachers' classrooms. The researchers analyzed the contributions of the individuals in the group in terms of number of messages shared amongst group members. While results indicated no statistical differences between distinctive core and periphery sub-groups, the researchers reported core peripheral members were influenced by the time of the message posting. That is, an early posting increased the probability that a participant would get reply messages from the rest of the group; consequently this illustrated the centrality of the network. They also reported core members exchanged many messages with multiple others, while periphery participants exchanged fewer messages overall.

Fahy, Crawford, and Ally (2001) analyzed the interaction patterns in an online conference from an online graduate course, using an approach that focused on the transcript's interactional and structural features. The Transcript Analysis Tool (TAT) was used to analyze interactional features, while structure elements suggested by social network theory were examined. Based on social network concept (Ridley & Avery, 1979 cited in Fahy et al., 2001), the structural features of interest in the investigation included the physical dimensions of the network, and the potential and actual levels of interaction revealed by the size, intensity, and the density. Interactional features were reflected in the TAT analysis of sentence types (questions, statements, reflections, engaging comments, and quotation/citations) found within the transcripts. Interactional features found in analysis of the postings that comprised the conference transcript included the kind of content exchanged in the interaction and the exchange of flow in the resulting interaction.

Fahy, Crawford and Ally (2003) reported that the size of the network was a major structural determinant of the feasible level of involvement for a given network. Analysis of the structural features demonstrated that as the size of the network grew arithmetically, the number of potential links grew proportionally. Density and intensity measures indicated high levels of variability in the participation and connectedness of network members. The TAT showed the proportions of five major types of sentences in the transcript corresponding to different modes of messages. In this study, the largest proportion of students' sentences was direct statement, and the next largest category was reflections. The authors indicated this suggested that the predominant discourse type in this conference was expository, oriented to the transfer of information.

As indicated in the studies reviewed in this section, a social network analysis method provides an opportunity to examine more complex features of interaction in a social process and present the visualization of networked interaction. However, several questions still remain: What factors affected density, intensity, or participation in the data? What does density and intensity mean for the social

process of learning? How are levels of interaction related to density, intensity, and participation? What is the contribution of each pattern in the social process? These questions needs to be further examined to explain how density and intensity of networked support and/or impact learning.

Themes and Discussion

This article explored the concept of collaborative learning supported by Web-based technology. A review of research provided insight into the types, levels, and patterns of interaction in WBL. Yet, researchers to date have not been successful in presenting findings that describe a social process of learning (Alavi & Duftner, 2005). In the next section, we assess each category to identify opportunities and challenges for continuing research in this area.

Types of Interaction

The descriptions of the types of interaction are a useful first step for understanding dialogue in online learning environments. However, in a complex and dynamic context such as WBL, we need to reassess each type on a continual basis. For example, the discourse generated by participants in WBL is different from face-to-face classroom discourse (Davis & Brewer, 1997; Mann & Stewart, 2000; Yates, 1996). In this context, as a group of learners and instructor(s) interact, different resources are intertwined and learning is organized and controlled by human interaction and technology (i.e., interface). We cannot simply categorize the interaction as learner-learner, learner-interface, or learner-content when examining asynchronous discussion. While we can identify actors in this process, examining the underlying social processes of learning is a challenging task using the current technological infrastructure.

We do not believe we need to add different types of interaction to the

framework. Rather, we propose that a new way of looking at the types of interaction is needed. As Hirumi (2002) proposed, to understand and investigate a complex learning environment such as WBL, we should consider each type of interaction within a specific context. Specifically, Hirumi suggested a "multi view" of the types of interaction consisting of three levels: individual learners' self-interaction, learner-human interaction and learner-non-human interaction (i.e., resources, technology, content), and learner-instruction interactions.

This new way of looking at interaction should also include consideration of multiple levels of types of interaction (e.g., learner-learner, learner-content, learner-interface see Bell, 2002) as well as unique features of online interaction (e.g., vicarious interaction, see Sutton, 2001). Research focused on interaction amongst group members, which is the critical component to understand student's collaborative learning, is important. However, the different interactions afforded by the technology (i.e., synchronous and asynchronous) and how the technology influences the interaction, whether supportive or challenging, should be fully examined in the future research.

Levels of Interaction

As described earlier in this paper, the detailed descriptions of the levels of interaction have provided a descriptive analysis scheme that might assist with explicating the social process in online discussion. This does not mean the research to date successfully explored interaction as a social process. Researchers have analyzed how an individual's message is conveyed in WBL; however, the research often ended with quantification of the results, such as how many messages of each level of interaction are generated. In studies to date, a set of pre-established "codes" was typically applied to the data set. This process is not sufficient to explain the social processes involved in the discussion. Further research is needed to explore how individual representation of meaning supports the group process and how each level of interaction is related to another.

Researchers have expressed concerns with existing analysis protocols (Fahy, 2001; Kanuka & Anderson, 1998; Marra et al., 2004). The question that then arises is: do we need to develop yet another analysis protocol? We believe the answer is not simply yes - or no. Rather, we recommend that the analysis be informed by the research design. The representation of the findings can then be used as a guide to examine the social processes of learning, rather than simply reporting what the individual messages contain. To accomplish the task, as Hannafin and Kim (2003) suggested, we need to ask a different questions such as how technology affordances enable collaborative learning experiences, and how collaborative learning is demonstrated in discussion including explicit interaction (i.e., posted messages) and implicit (i.e., vicarious interaction) interaction.

Studying the levels of interaction is not easy to implement (Järvelä & Häkkinen, 2003). One reason why it may be so challenging is the lack of extensive data. Our research experience indicates that one single data set is not sufficient to examine the social process of learning. The triangulation of data may help in this regard. As Järvelä and Häkkinen (2003) suggested, transcripts of a discussion board can be examined along with transcripts from stimulated recall interviews and reflective group discussions after the session as well as individual learners' reflection during the session. Further, as discussed earlier, to analyze a social process of learning, exploring appropriate research methodologies is needed, thus not restrict to interpret undiscovered characteristics of learning process.

Patterns of Interaction

One of the greatest benefits of employing social network analysis is the visualization of the interaction. Results of studies can be depicted with different nodes (representing participants) and links (representing different patterns of relationship among participants), including the size, density, and centralization of the interactions. While social network analysis provides an opportunity to examine complex and dynamic interactions in a group context, this method does not fully

support the investigation of how the social process of learning occurs in different webs of interaction. One of the challenges in the process could be how we can reflect asynchronicity of interaction in the diagram. Without careful consideration of the unique attributes created by time, the technology system, and students' behavior, the visualization of the interaction may not enable researchers to examine the actual relationships within the interaction. This needs to be explored in future studies.

The data analyzed to uncover patterns of interaction is also a challenge. Studies using a social network analysis of WBL usually take computer logs as an input and examine how the network is centralized and/or the density of the network. Analyzing the relationship of interaction does not enable us to examine what has been said, and what has been done by saying. For example, in an asynchronous discussion, one participant may reply to multiple participants and multiple messages at the same time. Without a detailed examination of students' behavior and the content of the individual message, we cannot fully describe how or what interaction occurred. To overcome this challenge, as mentioned in a previous section, triangulation with other data (i.e., survey, interview) and different analysis methods (e.g., discourse analysis) are needed to describe the learning process.

Another challenge in analyzing patterns of interaction comes from the asynchronous mode of communication. In an asynchronous discussion, time independence exists; yet, multiple participants can be engaged in the discussion at the same time. When one student posts a message in response to an idea, others may be reading the previous message and not see the reply immediately. In the asynchronous mode, multiple participants may be creating messages at the same time, but the appearance of the message (i.e., posting) depends on the computer and network technology. Because of this, online discussion is often considered a quasi-synchronous mode of communication (Gracias & Jacob, 1999). As Beck et al. (2003)'s study showed the time of posting influenced the formation of interaction (i.e., centrality) in the discussion. However, as they indicated, it may not be possible

to explain how the time factor influenced the social process in terms of quality; this should be further examined in future study.

Conclusion

As reviewed, different theories and research methods have been applied to extend our understanding of a social process within an online learning environment. After examining the theories that have been used to frame the research and how the research in this area has been conducted to date, we cannot simply infer that existing theory has not been successful to investigate a social process of learning. Rather, we conclude that the data analysis methods require more attention in future studies. In exploring different analysis techniques, we believe the research can move closer to an examination of not only what is said, but also what the saying enables in terms of learning.

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