

TOWARDS RIGOR OF ONLINE INTERACTION RESEARCH: IMPLICATION FOR FUTURE DISTANCE LEARNING RESEARCH.

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ABSTRACT

For the past decade, distance learning research has shifted the focus from defining the notion of distance as a physical proximity or separateness to a psychological construct such as social presence. We have also witnessed the increasing number of research studies that have examined the role of interaction as a way to minimize psychological distance. However, the overall quality of online interaction research has been questioned due to the lack of rigorous methods, and the overly-positive assumption about the relationship between quantity and quality of interaction. This theoretical paper argues that future online interaction research in the area of distance learning should move beyond merely comparing the types or amounts of interaction, and that more rigorous criteria should be employed to design, implement and evaluate online interaction research studies. This paper presents a design-evaluation framework particularly focusing on the three dimensions of learning research on interaction: a) the conceptualization of interaction, b) the tight coupling of the pedagogical-technological design, and c) the valid and reliable evaluation. It is hoped that this paper will highlight critical theoretical and methodological issues for future research to consider for the advancement of our knowledge on the role of interaction in distance learning environments.

Keywords: Distance Learning, Online Interaction, Interactivity, Design, Evaluation.

1. INTRODUCTION

Interaction has been regarded as a key component of effective instruction in both traditional face-to-face and technology-mediated learning environments. Generally, in the context of distance learning, interaction refers to a reciprocal communication and learning process between two or more human actors (e.g., instructors, other learners) or between learner and non-human agents (e.g., computers). The importance of interaction increases within the context of distance learning since learners are physically separated from instructors and other learners, and this physical distance affects learners' perception of psychological distance. Recognizing the importance of interaction in distance learning contexts, previous research has attempted to answer some fundamental issues: How do students perceive interaction as a critical component? How can instructional technology and pedagogical approaches be used to facilitate interaction? How does the increased use of interaction improve learner engagement in learning processes?

Generally, in online interaction research, there is a widely-accepted belief that the use of interactive technology with the affordances of two-way communication and multiple representations may provide more interactions for online learners, and thus lead to enhanced learning outcomes. This belief has been supported empirically to some extent. In a comprehensive meta-analysis, Zhao, Lei, Yan, Lai, and Tan (2005) found that interaction is a key component in deciding the effectiveness of distance learning compared to face-to-face instruction. Specifically, they found that distance learning programs providing opportunities for both synchronous and asynchronous interactions reported more positive outcomes than programs with a single mode of interaction. Other research studies have suggested positive relationships between the amount of interaction and the perceived level of satisfaction, implying that more interaction is better for affective aspects of learning in distance environments (Driver, 2002; Jung, Choi, Lim, & Leem, 2002; Thurmond, 2003; Thurmond, Wambach, & Connors, 2002).

Some researchers, however, have argued that this assumption regarding the overly- positive relationship between instructional delivery systems and instructional interaction should be critically and empirically examined (Anderson, 2003a; Moore, 1989; Sims, 2003; So & Brush, 2008; Wagner, 1994): how does the increased quantity of interaction mediated by interactive technologies improves the quality of learning in online learning contexts? For instance, Beaudoin (2002) argued that a high amount of learner interaction is not always necessary for online learning because witness learners or low-visibility learners, who did not actively participate in learning via written responses, in fact, spent a significant amount of time in learning-related activities, and also had opportunities to learn vicariously. Similarly, Godwin, Thorpe, and Richardson (2008) reported in their study of 36 distance learning courses that learning outcomes were independent from the levels of interaction and technology integration. The main intent of these studies may not be to completely oppose the importance of interaction in distance learning. Rather, they emphasize that interaction should be carefully planned, implemented and evaluated as one of the critical instructional components rather than as an imposed and enforced component, and that both positive and negative impacts of interaction should be considered equally.

For the past decade, predominant themes of online interaction research have centered on examining a) which type of interaction is perceived as an important factor by learners, and b) whether a different amount of interaction can affect student satisfaction and academic performances. This research trend is characterized as “the interaction-versus-distance scheme in which a negative connotation is implicitly attached to the notion of distance, as it is something to be overcome by increasing the level or frequency of interaction” (Shin, 2002, p.122). However, Wagner (1997) cautioned that interaction should not be seen simply as a quantifiable attribute:

One might attempt to quantify the amount of interaction that is needed to ensure the quality of a learning experience. One may be interested in determining how often interaction should occur for a learning experience to be effective. There may be some interest in determining what types of interaction is the most effective. However, it is hard to imagine that the result of any of these inquires would offer any useful insights or understandings. (p.25)

Furthermore, Anderson (2003a) argued that meaningful learning experiences can be achieved as long as the level of one interaction among three types (learner-learner, learner-instructor, and learner-content) is high. This equivalency theorem may suggest that research comparing types of interaction against each other (e.g., is learner-learner interaction more important than learner-instructor interaction?) has little pedagogical and practical values. To move beyond merely comparing the types or amounts of interaction, rigorous criteria should be used to design and evaluate research studies. The purpose of this theoretical paper, therefore, is to propose a framework for designing and evaluating online interaction research, drawn from the literature on distance learning research studies. In the conclusions, suggestions for future empirical research on interactive learning environments are presented.

2. ONLINE INTERACTION RESEARCH

Research studies are largely classified into three categories: (a) what is, (b) what may be under generalizable conditions, and (c) what may be under a particular condition (Frick, 2004). First, in the context of interactive online learning research, theoretical studies aim to operationally define what is the concept of interaction based on descriptive theories such as learning and communication theories (e.g., Hillman, Willis, & Gunawardena, 1994; Moore, 1989; Sutton, 2001; Wagner, 1997). A second category is the instructional design and development studies that provide prescriptive instructional strategies about how to design interactive instruction under general contexts (e.g., Gilbert & Moore, 1998; Hirumi, 2002; Strijbos, Martens, & Jochems, 2004). Finally, experimental studies evaluate the effectiveness of interaction on learners’ cognitive and affective learning outcomes under contextualized conditions (e.g., Moallem, 2003; Northrup, 2002; Vrasidas & McIsaac, 1999).

Different criteria should be applied to design and evaluate the three types of research since the purposes of inquiry and research outcomes in each type are different (Frick, 2004). Studies that provide the conceptualization of interaction need to be evaluated based on the pedagogical soundness of theories while instructional design studies should be evaluated in terms of their systemic and systematic design process, and applicability to real settings. Experimental studies, on the other hand, need to be evaluated in terms of research design, theoretical background, valid and reliable assessment, measured outcomes, and theoretical and practical implications.

With regard to the rigor of research on interaction conducted in distance learning contexts, this paper suggests that researchers should consider the following three dimensions for design and evaluation:

- The Conceptual Definition Dimension: Defining interaction with theoretical grounds
- The Pedagogical-Technological Design Coupling Dimension: Tight coupling of pedagogical methods and technological affordances
- The Evaluation Dimension: Empirical measurements on cognitive and affective learning outcomes

Table 1 below lists the main dimensions and critical questions associated with each dimension. In-depth discussions of each dimension are presented in the following sections.

Table 1. Dimensions and critical questions for evaluating online interaction research

Dimensions	Critical Questions
Conceptual Definition	Is the conceptualization of interaction grounded on relevant theories? What are the types of interaction? Do the researchers make a distinction between instructional interaction and system interactivity?
Pedagogical-Technological Design Coupling	How does the research employ instructional methods that go beyond replicating traditional classroom teaching methods? How does the research take advantages of media to facilitate interactive learning processes? How are the methods and media coupling used in the research appropriate for the learner, instructor, learning content, learning outcomes, and environment?
Evaluation	How do the researchers develop and/or use valid and reliable measurement tools? How does the research provide empirical evidence that interaction affects learners' cognitive performance? How does the research provide empirical evidence that interaction affects learners' attitude?

3. THE CONCEPTUAL DEFINITION DIMENSION

Even though interaction is a common term often discussed in distance learning contexts, a lack of functional definitions has been a serious problem in forming basic and shared understanding among researchers and practitioners. Moore (1989) emphasized the need for a clear and functional definition of interaction by stating that “interaction is another important term that carries so many meanings to be almost useless unless specific sub-meanings can be defined and generally agreed upon” (p.1). Therefore, it is important for researchers to clearly conceptualize the meaning of interaction grounded on relevant theories. An example of the functional definition of interaction grounded in theory is found in the work by Vrasidas and McIsaac (1999). They defined interaction as “the process consisting of the reciprocal actions of two or more actors within a given context” (p.25). This definition is theoretically based on the symbolic interactionism which emphasizes the interpretations of meaningful perspectives by human actors.

Another critical question in the conceptualization dimension is whether researchers specify types of interaction. As shown in Table 2, within the literature, two main means of categorizing interaction have been suggested: a) interaction with learning agents and b) interaction for learning outcomes. Learning agents focus on interaction with human agents or non-human agents while learning outcomes focus on the role of interaction as a means for accomplishing certain learning activities and outcomes.

In the first category on learning agents, several previous studies have used the three types of interaction proposed by Moore (1989) - (a) learner and content interaction, (b) learner and instructor interaction, and (c) learner and learner interaction- as a theoretical framework. In addition to the three types of interaction, Hillman, Wills, and Gunawardena (1994) presented interaction between learner and interface as a fourth type of interaction. They stressed that “the learner must interact with the technological medium to interact with the content, instructor, or other learners” (p.33). Vicarious interaction is another important type of interaction that occurs in distance learning environments. As vicarious learning involves active observations of other actors' behaviors, vicarious interaction occurs when distance learners observe the process of interactions between other learners and instructors (Fulford & Zhang, 1993; Sutton, 2001).

While the types of interaction discussed above focused on learning agents, Wagner (1997) addressed a need to shift the focus from learning agents to learning outcomes, and suggested twelve types of interaction, including interaction for participation, communication, team-building, exploration, and so on. Emphasis on learning outcomes helps specify instructional means to achieve a certain goal of interaction.

Table 2. Types of interactions based on learning agents and outcomes

Learning agents	Learning outcomes
Interaction with whom (human) or with what (non-human)?	Interaction to achieve what?
Moore (1989)	Wagner (1997)
1. Learner – Content interaction	Interaction for participation
2. Learner – Instructor interaction	Interaction to develop communication
3. Learner – Other learners interaction	Interaction to receive feedback
Hillman, Wills, & Gunawardena (1994)	Interaction for elaboration and retention
4. Learner – Interface interaction	Interaction for learner control and self-regulation
Sutton (2001)	Interaction to increase motivation
5. Learner – Learner him or herself (Vicarious interaction)	Interaction for negotiation of understanding
	Interaction for team building
	Interaction for discovery
	Interaction for exploration
	Interaction for clarification of understanding
	Interaction for closure

Finally, the conceptualized meaning of interaction should be distinguished from similar terms such as interactivity, transaction, and social presence that are often used interchangeably. Instructional or social interaction as a process of learning events needs to be differentiated from system interactivity as an attribute of technology (Anderson, 2003b; Wagner, 1997). In multimodal learning environments, for instance, Moreno and Mayer (2007) defined interactivity as the responsiveness of learners' actions associated with the use of technology during learning processes, and suggested that there are five types of interactivity: dialoguing, controlling, manipulating, searching, and navigating. High-level interactive learning is possible when technical systems allow communication between learners and some of these interactivity types.

Social presence and transaction are other terms often used related to interactivity or interaction. In differentiating social presence and interactivity Gunawardena and Zittle (1997) argued that “interactivity is a quality (potential) that may be realized by some or remain an unfulfilled option for others. When it is realized and when participants notice it, there is ‘social presence’” (pp. 10-11). For example, when learners make online postings as a fulfillment of minimum requirements and do not actively engage in responding to other postings, it is hard to say that meaningful interaction occurs through the system interactivity of online discussion forums. Woods and Baker (2004) argued that this type of minimum engagement with little intent of continuous communication can be described as a term transaction. This discussion of different terms suggest that for higher levels of interaction, learners should take actions to utilize the affordances of technical interactivity for ongoing communication and engagement, and in turn this activation needs to affect the development of connected feelings with other human actors.

4. THE PEDAGOGICAL-TECHNOLOGICAL DESIGN COUPLING DIMENSION

Often, it is assumed that the use of interactive two-way communication technology enables meaningful interactions to occur. This assumption about a causal relationship between interactive technology and instructional interaction has produced hardware technology-driven research (Jonassen, 1985). An example of hard technology-driven research is media comparison studies which attempt to find the best delivery technology. However, most media comparison studies concluded that there were no significant differences among different types of delivery technologies (Clark & Mayer, 2002; Lockee, Burton, & Cross, 1999). Furthermore, these research studies often fail to examine the transformative nature of interaction across time and space through the mediation of technology. More emphasis should be placed on how to systematically design the aspect of soft technology as well as hard technology, which is named as a coupling of the pedagogical-technological design in this paper.

First, research on interaction should go beyond simply replicating traditional classroom teaching methods, and employ instructional methods appropriate and unique in online learning contexts. The reality, however, is that several forms of online learning often follow an instructor-centered didactic model that gives little opportunities for interactive and collaborative learning. It appears that while interactive technologies have advanced rapidly in the past decade, pedagogical changes in online learning from delivery-centered to interaction-centered formats have been slow as seen in the predominant use of online lecture files and non-interactive media. Rather than centering the notion of interaction on technology itself, synergized effects by a tight coupling of the pedagogical-technical design should be re-examined.

For instance, computer-supported collaborative learning (CSCL) is an area where such efforts have been sought for in-depth understanding of the role of interaction in collaborative learning processes (Koschmann, Hall, & Miyake, 2002). The main inquiry of CSCL research is how to utilize the affordances of computers as a mediating tool to support the interaction of participants for shared understanding and meaningful knowledge building, where a community of learners works collaboratively towards in-depth understanding that individual learners may not reach alone (Scardamalia & Bereiter, 1994). While CSCL research encompasses both face-to-face interaction and technology-mediated interaction, findings related to the tight coupling of the pedagogical-technical design, such as scaffolding design, interaction analysis, and online community models, can bring valuable insights to research studies examining how to design interactive distance learning environments.

Another related question in this dimension is associated with the selection of effective and efficient media. While there are diverse ranges of instructional media available in distance learning, from the simple Web technologies to learning management systems to highly interactive environments (e.g., virtual games, simulations), the selection of media in most cases is constrained by pedagogical, financial, and practical factors. From pedagogical perspectives, while it is efficient to use simple one-way technology in a teacher directed learning mode, the use of sophisticated technology is necessary in a collaborative learning mode to allow for more learner control, social interaction, and collaboration. More importantly, as mentioned earlier in distinguishing learning interaction from system interactivity, it should be noted that technological systems supporting multiple modes of interaction such as online games and simulated 3D environments do not necessarily lead to interactive learning, and potential limitations on cognitive-social aspects of learning (e.g., cognitive load, Moreno & Mayer, 2007) need to be considered equally.

Thus, an important issue for designing interactive learning environments is how to decide on the types of communication technologies for the design of meaningful interaction. Design and technical frameworks based on the types and levels of interaction can be used in this decision. For example, Strijbos, Martens, and Jochems (2004) proposed a process-oriented framework for interaction design in CSCL environments, including five critical elements: learning objectives, task type, level of pre-structuring, group size, and computer support. Each element should be carefully designed and redesigned around the expected interaction, and successes and lessons learned from this process of design should be reported. Similarly, Chou (2003) suggested a technical framework for designing interactive functions to support types of interaction in designing web-based learning environments. These frameworks can be useful tools that guide systematic design processes focusing on critical pedagogical and technological dimensions of interaction.

Finally, it is critical to select instructional methods and media based on the thorough considerations of contextual variables. The traditional sense of replicability for generalization is hard to achieve in online interaction research due to the transformative and context-sensitive nature of interaction. Thus, it is important to examine interaction with associated situational variables such as learner characteristics, learning goals, and instructional settings. With this regard, design research methodology can be employed to carefully document learning contexts and local impacts. Design research, also used interchangeably with design experiments, design-based research, and design studies, is a methodology focusing on the advancement of both theory and practices through the multiple iterations of enactment and progressive refinement (Collins, Joseph, & Bielaczyc, 2004). Design research, compared to traditional experimental approaches, has particular potentials in online interaction research since multiple sources of quantitative and qualitative data are collected and synthesized to disentangle the complex nature of interaction in real-world online learning environments. Additionally, detailed descriptions of learning contexts and lessons learned can allow other researchers and practitioners to understand how to re-contextualize research findings to local contexts and to minimize the chance of repeating similar mistakes (Barab & Squire, 2004).

5. THE EVALUATION DIMENSION

The most common research approach in instructional technology has been the media comparison study which compares learning outcomes via one instructional medium against those via a traditional (mostly lecture and textbook based) medium (Lockee et al., 1999). An inherent problem in these studies, however, is that most of them concluded that there was no significant difference (NSD). Spenser (1991) suggested that results from most media comparison studies are based on “a ‘box score’ tally approach, frequently resulting in a small number of studies favoring the innovation, a similar number favoring the traditional approach, and the vast majority showing NSD” (p.13). Despite this criticism, media comparison studies are still prevalent in arguing for the effects of certain media types. Although there have been ongoing debates regarding whether media or methods influence learning, it is clear that simple media comparison studies do not provide useful theoretical and practical implications to other researchers and practitioners. Indeed, in online interaction research there is a need to go

beyond simply comparing different types of technology itself. There is a need to place more emphasis on examining complex aspects of the interplay between technology and learning.

To this end, the first critical question in the evaluation dimension is the validity and reliability of instruments used to measure online interaction. As most research questions in the instructional technology area show, interaction is a complex concept that is difficult to define and measure. Wagner (1994) addressed the difficulty of defining interaction as an independent variable by stating that “speculating about the role, impact, and effect of interaction is far easier than is establishing working hypotheses and measuring the effect on student achievement” (p.20). Although much research has provided theoretical foundations, overall few research studies employed valid and reliable instruments, as seen in a dominant number of single survey studies.

Despite the difficulty of establishing the construct of interaction, researchers do need to specify how to measure the effect of interaction on cognitive and affective learning domains. Generally, there has been much criticisms about the quality of distance learning research, and the lack of valid and reliable instruments has been pointed out as one of main reasons for this issue (Bernard, Abrami, Lou, & Borokhovski, 2004). In the review of research on the effectiveness of distance learning, Phipps and Merisotis (1999) suggested that although valid and reliable instruments to measure learning outcomes and student attitudes are essential in a well-constructed research, most studies in distance education have not provided detailed information about such instruments.

Another important question in the evaluation dimension concerns measuring learning outcomes, in both cognitive and affective domains. On the whole, while various researchers have contributed to examine affective outcomes such as learner satisfaction and perception of interaction, there has been little research that investigated the relationship between interaction and learning performances (Picciano, 2002). This phenomenon may be associated with the difficulties of controlling extraneous variables and establishing relationships between interaction and learner achievement. Obviously, traditional approaches of experimental research design, often relying on pretest and posttest comparisons, have inherent problems in interpreting results when we accept the view of learning as a socially situated construct. Furthermore, learning outcomes are often measured through survey items and counting the number of postings at an individual level, thus missing out on learning at group and community levels. For instance, Stahl (2002) criticized that the richness of the interactive learning process through the mediation of technology is often lost when researchers try to reduce process data and treat interaction as a quantifiable entity as seen in quantity-oriented content analysis methods. To overcome these methodological issues, researchers should try to capture both the process and product of interactive learning, at both the individual and group level understandings.

6. CONCLUSION

In the past decade, distance learning research has shifted the focus from defining the notion of distance as a physical proximity to a psychological construct. According to Garrison (2000), a theoretical challenge of distance learning research in the new century is to move away from structural and standardized assumptions to in-depth examination of transactional issues. However, studying interaction as a cognitive-social construct is complex especially under distance learning environments since the learning process is mediated through technology, and further distance in both the physical and psychological domains creates a great deal of situational variables that researchers may not be able to control and examine. Indeed, while there has been growing research interests in the role of interaction in online learning environments, the overall quality of research has often been criticized for the lack of research employing rigorous methods. Additionally, the excessive use of single survey studies and media comparison studies has been a barrier for the advancement of our knowledge on the role of interaction and learning.

Towards the rigor of online interaction research, this paper questioned the overly-positive assumption between instructional interaction and the use of interactive technology, and provided a framework for design and evaluation. Three dimensions that this framework particularly focused on are the conceptualization of interaction, the tight coupling of the pedagogical-technological design, and the valid and reliable evaluation. Critical questions associated with each dimension were also discussed. As emphasized throughout this paper, the use of interactive technology supporting multi-modal learning does not necessarily mean that learners are engaged in meaningful interactive learning. Potential negative effects of excessive interaction and forced interaction should be equally considered with positive effects.

In conclusion, online interaction is a complex concept to examine as it involves other agents and mediating tools. Understanding this complexity, future online interaction research should be reframed to focus on learning effects with a tight coupling of the pedagogical-technical design, rather than simply examining interaction as a quantifiable attribute separated from contextual variables. For the rigor of future online interaction research,

there is a need for more comprehensive research methodology, and this paper suggested that design research using mixed methods holds great potentials for building more robust theories of online interactive learning. In addition, future studies need to develop reliable and valid instrument tools to measure the impacts of online interaction on various learning outcomes. It is hoped that this paper has highlighted critical theoretical and methodological issues that future research needs to consider for the advancement of our knowledge on the role of interaction in distance learning environments.

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