

# ***COMPUTER-MEDIATED COMMUNICATION, ELEARNING, AND INTERACTIVITY***

## ***A Review of the Research***

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This article reviews research related to computer-mediated communication (asynchronous and synchronous online communication), eLearning, and interactivity, examining the multiple operational definitions of interactivity, types of interactions present in studies, and the instructional strategies and activities suggested by the research. Definitions of interactivity are categorized from themes emerging from the review, gaps in the research are identified and common research conclusions across studies are presented to provide linkages from research to practice.

...[W]e cannot truly transform educational practice for the better through utilizing new technologies unless we examine the roles the computer can play in truly stimulating, supporting and favoring innovative learning interactions that are linked to conceptual development and improvements in understanding (Ravenscroft, 2001, p. 134).

There is consensus among theorists, researchers, and practitioners of educational technology and distance education that interactivity is a critical variable in learning (Berge, 1999; Kearsely, 1995; Moore, 1993). There are many ways to promote interaction, particularly in current eLearning contexts and, as a result, multiple definitions of the construct. For truly

innovative learning interactions to occur and be associated with specific improvements in learning, the fields of educational technology and distance education need to identify and better define the various forms of interaction possible within eLearning. Clear terminology and use of common operational definitions of interaction are needed to provide clarity in the interpretation of research results and future research efforts.

Promoting common definitions and interpretations of interaction in the educational technology and distance education literature proves challenging as many terms that encompass interactions such as eLearning, computer-

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mediated communication, and online learning are used interchangeably. The most recent term, "eLearning" has been defined as the use of Internet technologies to deliver a broad array of solutions that enhance knowledge and performance (Rosenberg, 2001, p. 28). Computer-mediated communications (CMC), a more prominent term found in the research literature, is defined as "communication between different parties separated in space and/or time mediated by interconnected computers" (Romiszowski & Mason, 1996, p. 439). Hirumi (this issue) provides some intersection between these two definitions, establishing eLearning as "learning that is facilitated predominately through the use of telecommunication technologies such as electronic mail, electronic bulletin board systems, inter-relay chat, desktop videoconferencing and the World-Wide-Web." Incorporated within this definition of eLearning, CMC broadly describes many of the instructional delivery mechanisms that can support complex processes of interaction that are essential to eLearning.

Engendering further confusion in the field are the multiple definitions of interactivity that are espoused in the published literature related to eLearning and CMC. For example, interaction has been defined as "...an instructional strategy that provides the student the means of being actively involved in the learning activity" (Bills, 1997, p. 4) or the "reciprocal actions of two or more actors within a given context" (Vrasidas & McIsaac, 1999, p.25). Other more encompassing definitions include Berge's (1999) description of interaction based on integration of previous work in this area as:

two-way communication among two or more people within a learning context, with the purposes either task/instructional completion or social relationship-building, that includes a means for teacher and learner to receive feedback and for adaptation to occur based upon information and activities with which the participants are engaged. (p.6).

Considering the large number of variables related to this construct, it is not surprising that it is difficult to agree on what is interaction (Soo & Bonk, 1998).

Wagner (1994) raised the issue of confusing terminology, stating: "...[O]ne of the major difficulties surrounding discussions of interaction and interactivity is that these terms, while widely used, have not been clearly or functionally defined" (p. 6). Despite Wagner's attempt to clarify the term, multiple definitions persist, limiting the usefulness of related theoretical discussions and research efforts. For example, reviews of the literature on interactivity, such as Flottemesch's (2000) have focused only on student-to-student or teacher-to-student interaction, ignoring other forms involving individual knowledge construction, metacognitive self-reflection, or participation in learning contexts with various technologies and multiple instructional strategies.

This review attempts to provide a comprehensive synthesis of the multiple definitions of interactivity found in the primary research reported in educational technology academic journals. Examining research studies that incorporate CMC delivery methods in an eLearning context reveals multiple operational definitions of interactivity. This body of research is examined for commonalities or differences in the operational definition of interaction and organized based on categories that emerge from the compilation of studies. It is hoped that synthesizing the literature related to CMC, eLearning, and interactivity will lay the groundwork for a clearer understanding of interactivity and provide useful recommendations for both research and practice.

## **METHODS AND PROCEDURES**

According to Cooper (1985), "...a literature review seeks to describe, summarize, evaluate, clarify and/or integrate the content of primary reports" (p. 7). In reviewing studies related to eLearning, CMC, and interactivity, it is clear that these research topics require additional

clarification. Consensus on the description of the construct of interactivity, integration of the varying operational definitions, and evaluation of disparate research outcomes related to interactivity can only assist in pushing the research in this area forward. Although literature reviews can have many different focuses, goals, perspectives, coverage strategies, organizations, and audiences, one significant purpose of a literature review is to "...build bridges between related topic areas" (Cooper, 1985, pg. 3). Hare and Noblit (1983) termed this type of review an explanatory synthesis that requires both qualitative and quantitative data to overcome communication problems in the field of study to promote understanding and unify conflicting perspectives. A sole focus on quantitative studies in more common meta-analytic procedures are applicable for literature reviews that seek to synthesize research outcomes and are not appropriate for other goals such as tracing the development of a particular construct through the literature or integrating multiple definitions of a concept to promote clarity of terminology (Cooper, 1988).

The purpose of this review is to provide an explanatory synthesis of the literature related to the construct of interactivity contained in studies that seek to facilitate eLearning through the use of computer-mediated communications as the primary instructional delivery mechanism. The purpose of an explanatory synthesis literature review is to emphasize similarities and differences across studies to promote shared concepts and language as well as create a conceptual bridge in translating research to practice (Hare & Noblit, 1983). This type of review focuses on the processes of comparison promoting an interpretive perspective on the literature.

Cooper (1985) determined that important components for research synthesis are the specific focus, goals, perspective of reviewer, coverage, organization, and audience. Reviews of the educational literature typically include two or three foci in one or more areas such as research outcomes, research methods, theories,

practices, or applications. The focus of this review includes theories that inform the construct of interactivity, related research outcomes and applied practices, or instructional strategies that result from the research. Additionally, Cooper (1985) stated that the goals of a literature review can incorporate (a) the formation of general statements from multiple instances, (b) resolving conflict between ideas by proposing a new conception that accounts for the inconsistency, and (c) bridging the gap between theories or disciplines by creating a common linguistic framework. The current explanatory review focuses on the creation of a common linguistic framework related to interactivity.

The perspective of the reviewer can be identified as neutral in providing little personal interpretation or evaluation or espousal in promoting advocacy of a particular view or methodology. However, the same work can initially contain a descriptive review and later incorporate an interpretive perspective. A combined descriptive and interpretive perspective describes the point of view contained in this article.

Coverage is another characteristic representative of literature reviews. Cooper (1985) identified four levels of coverage, including:

- a. exhaustive that includes a comprehensive representation of work relevant to the topic,
- b. exhaustive with selective citations where the review is comprehensive but only a selected sample of works are described in the paper,
- c. representative that encompasses selected works that demonstrate larger bodies of literature in the field, and
- d. central or pivotal that reports only initial work that have provided direction for a particular field of study.

This review attempts to be exhaustive, demonstrating a comprehensive review of published journal articles in the field of educational tech-

nology related to interactivity and evidenced in studies involving CMC and eLearning.

Organization and audience are the two final characteristics noted by Cooper (1985). Reviews can be arranged historically, in chronological order; conceptually, with works relating to the same ideas; or methodologically, incorporating similar methods as subtopics. In addition, reviews can be targeted to specific or multiple audiences. The attempt here is to organize the review conceptually, with works related to interactivity in eLearning or CMC, and to have the review provide insight for both researchers and practitioners.

Cooper (1988) also presents appropriate stages of the research synthesis that include: (a) problem formulation, (b) data collection, (c) data evaluation, (d) analysis and interpretation, and (e) presentation of results. This article is organized and presented according to these required stages. It is hoped that the review represents the state of knowledge of literature related to eLearning, CMC and interactivity, creates conceptual bridges across concepts, and highlights some important issues that research has left unresolved.

### **PROBLEM FORMULATION**

As expressed by Hirumi (this issue), interactivity is a crucial variable in distance education; however, it is not well defined. Multiple definitions and interpretations exist, creating confusion in the conceptual understanding of the construct as well as in the interpretation of research results. Therefore, this study is directed toward answering the following questions:

1. How is interactivity defined and/or operationalized across research studies found in the literature related to eLearning and CMC?
2. How does the literature related to interactivity intersect with Hirumi's (this issue) three levels of planned eLearning interactions?

3. What similarities and differences are found in the operational definitions and research outcomes of interactivity found in literature related to eLearning and CMC, and how can these similarities and differences inform the research and practice of designing and developing eLearning environments?

### **DATA COLLECTION**

This study investigated several sources of information related to interactivity, including academic journals, academic databases, online journals, and solicited works from prominent researchers in the field, targeting quantitative or qualitative research studies that incorporated interactivity as a variable or theoretical construct during the years between 1995-2000. Other reviews of the literature have been conducted in areas such as interactive television or telecourses (Machtmes & Asher, 2000), hypermedia (Dillon & Gabbard, 1998) or distance learning technologies used prior to 1995 (Moore & Thompson, 1990). These studies reviewed literature related to particular technology delivery mechanisms rather than providing a focus on a particular conceptual construct such as interactivity and its relationship to specific technologies. They also provided a more traditional comparative meta-analytic focus rather than interpretive insights from an explanatory synthesis approach.

The search process included investigation of the ERIC database using search terms such as interactivity, eLearning, and computer-mediated communication. Related terms such as community supported collaborative learning (CSCL), synchronous communication, and online learning communities were also used to search the database. When that process did not yield as many results as expected, a meticulous search of prominent academic journals in educational technology between 1995-2000 (more recent articles from the year 2001 were included when available) was undertaken using the UNCOVER database. Table 1 lists

TABLE 1  
Searched Refereed Academic Journals (1995-2001)\*

1. Educational Technology Research & Development
2. British Journal of Educational Technology (1997-2000)
3. Journal of Interactive Learning Research (1997-2000)
4. Journal of Research on Computing in Education (1997-2000)
5. Interactive Learning Environment (1998-2000)
6. Instructional Science (1997-2000)
7. Journal of Interactive Learning Research
8. Journal of Distance Education (2000-2001)
9. American Journal of Distance Education
10. Open Learning
11. Distance Education
12. The Internet and Higher Education (1998-2001)
13. Educational Media International
14. Journal of Computing in Higher Education
15. Journal of Educational Multimedia & Hypermedia
16. Journal of Computer Assisted Learning
17. Australian Journal of Educational Technology
18. Quarterly Review of Distance Education (2000-2001)
19. Journal of Distance Education (1996-2001)
20. Journal of Asynchronous Learning Networks (1997-2000)
21. Journal of Computer-mediated Communication (1995-2001)

\* Searched issues from January 1995- November 2001 unless noted where the start of the journal was later than 1995 and 2001 issues were available through UNCOVER.

the targeted journals. In addition, online academic journals were accessed for relevant articles and several researchers prominent in educational technology who were known for their empirical work related to distance education and eLearning were contacted to obtain current work. Because interactivity has been previously examined in distance education environments including interactive television and hypermedia, studies involving these delivery mechanisms were excluded. A focus on obtaining literature that examined interactivity in relation to asynchronous and synchronous CMC and eLearning was maintained throughout the study.

### DATA EVALUATION

Using the described search process yielded 132 articles that were classified as primary research articles, consisting of descriptive, quantitative, and qualitative studies or conceptual articles that included primarily theoretical positions, evaluation, lessons learned, and other non-empirical writings. Of the total number of articles collected, 62% (83) of the 132 articles were categorized as primary research studies, while 37% (49) were conceptual in nature (Table 2).

The categorization of articles using search terms yielded interesting results. Using inter-

TABLE 2  
Number of Articles by Search Term

Type of Study	Search Term						Total	Percent of Total
	Interactivity	CMC	eLearning	Online Comm	CSCL	Synchr.		
Conceptual	22	13	6	3	3	2	49	37.12
Primary Research	21	37	0	4	17	4	83	62.88
<b>Totals</b>	<b>43</b>	<b>40</b>	<b>6</b>	<b>7</b>	<b>20</b>	<b>6</b>	<b>132</b>	

activity as a search term yielded the most articles (including primary research and conceptual) (43), followed by CMC (40), and computer supported collaborative learning (20). The CMC category included the highest number of primary research articles (37), with interactivity (21) and computer supported collaborative learning (17) following. However, the terms online communities, synchronous communication, and eLearning yielded no more than 19 articles collectively, with only 8 primary research articles for online communities and synchronous communication. Interestingly, eLearning as a search term yielded only 6 conceptual articles and no primary research articles across the academic journals examined. This may be a result of the recent emergence of the term eLearning in the literature and the higher incidence of use of more common terms such as computer-mediated communications prevalent in past research related to online learning.

Of the total number of 83 primary research articles, 21 articles included an operational definition of interactivity in

- a. explicitly defining the term in the theoretical grounding of studies,
- b. including the term in research questions, or
- c. providing an implicit definition of interactivity through presented results.

As expected, the highest percentage of primary research articles with an interactivity focus (approximately 47%) were collected using interactivity as a search term (Table 3). Primary research articles related to computer-mediated communication incorporate the con-

struct of interactivity in approximately 19% of the collected articles. Research literature referring to computer-supported collaborative learning integrates the concept of interactivity in approximately 11% of the studies published in these journals. The small number of primary research articles on topics such as online learning communities and synchronous seem to include interactivity about 25% of the time.

These results differed somewhat from Anglin and Morrison's (2000) study that categorized the distance education research contained in two academic journals, the *American Journal of Distance Education* and *Distance Education*. The current study initially located more primary research articles (approximately 62%, compared to Anglin and Morrison's 38%), most likely due to reviewing many more academic journals. However, instead of categorizing all the research in these journals, this review focused on identifying the primary research articles that operationalized the construct of interactivity and found that only 21 met the established criteria.

No attempt was made to eliminate studies based on perceived quality in this review. Cooper (1998) recommends that synthesists not make a priori judgments of article quality and include articles of questionable quality in reviews because they may contain variations in methods or other factors that can help to assist in answering other questions surrounding the problem area. As Cooper indicates, "Letting the data speak" (1998, p. 84) is a better practice for synthesizing research than allowing the subjective predispositions of the synthesist to determine which studies are appropriate, thereby missing valuable information. This study incorporated all relevant work to provide

TABLE 3  
Percentage of Primary Research Articles Including the Construct of Interactivity

Type of Study	Interactivity	CMC	eLearning	Online			Total
				Comm	CSCL	Synchr	
Primary Research	21	37	0	4	17	4	83
Interactivity Operationalized	10	7	0	1	2	1	21
Percentage Interactivity Focus	47.61	18.9	0	25.0	11.76	25.0	25.30

a comprehensive picture of interactivity in the published research.

### **ANALYSIS AND INTERPRETATION**

In their study, Anglin and Morrison (2000) expressed concern at the state of research related to distance education and concluded that those in the field need to progress beyond developing “pockets” of knowledge demonstrated by isolated research studies and provide additional theory building. This study reviews and integrates the many conceptual and operational definitions of interactivity represented in primary research studies, with the aim of guiding future research and theory building.

Bridging gaps between theories and ideas is a fundamental purpose of conducting a literature review (Cooper, 1998). This review revealed that interactivity is a construct with multiple definitions and interpretations. However, looking across studies, some commonalities emerge. Interaction can be viewed as a function of: (a) learners’ participation or active involvement, (b) specific patterns and amounts of communication, (c) instructor activities and feedback, (d) social exchange or collaboration, or (e) instructional activities and affordances of the technology. These definitional categories emerged from a holistic view of the primary research related to interactivity and eLearning. Each category and a synthesis of related studies are examined in turn. Appendix A summarizes definitions of interactivity across reviewed studies.

### **DEFINITIONAL CATEGORIES OF INTERACTION**

#### *Interactivity as Defined by Active Involvement by the Learner.*

McIsaac, Blocher, Mahes and Vrasidas (1999) examined both teacher and student perspectives of interaction in an online course using asynchronous computer conferencing. They determined that teachers perceived their interaction with students in an online course as

of higher quality than in traditional face-to-face courses. The implicit definition of interaction related to this conclusion seemed to indicate that individual students’ increased active involvement and participation as perceived by teachers in an eLearning environment provided evidence for interactivity. A more elaborate operational definition was provided in the study from the student perspective and encompassed the kind, nature, and perception of interaction by student participants. The researchers concluded that students have specific goals for each interaction in an eLearning environment, including getting help or sharing information related to the content of the course, getting help on the technology, submitting homework, and participating in discussion to exchange ideas or socializing. Each of these activities is learner-centered, placing much of the initiative and responsibility of learning on the students. This interpretation of interactivity implies that it is a construct related to active student involvement and responsibility from both the teacher and student perspectives.

Kanuka and Anderson (1998) examined social interaction and knowledge construction using an interaction analyses model outlined by Gunawardena, Lowe and Anderson (1997). This model of interaction relies on an active view of knowledge construction by the learner that moves through five phases, including:

- a. sharing/comparing of information;
- b. discovery and exploration of dissonance or inconsistency among ideas, concepts, or statements;
- c. negotiation of meaning and/or co-construction of knowledge;
- d. testing and modification of proposed synthesis or co-construction; and
- e. phrasing of agreement, statements, and applications of newly constructed meaning.

These activities provide an explicit definition of interaction based on a constructivist perspective and are learner-focused in nature.

Similarly, Zhu's (1998) study examining participation and roles in online discussions showed that a student's acquisition of new knowledge is dependent upon the amount of constructivist activities in which the individual is engaged, effort invested, and his or her level of prior knowledge. This research revealed that active students motivated, influenced, and facilitated the online discussion, while less active students merely assimilated information.

The studies reviewed above represent an operational definition of interactivity in an eLearning context that incorporates active involvement by the learner through his or her participation, goal setting, knowledge construction, and discussions. Although the researchers conceptualized the construct somewhat differently, the central theme across these studies reflects the specific nature and amount of learner involvement in instructional activities constitutes interaction.

### ***Interactivity as Defined by Patterns of Communication Among Learners/Instructors.***

A significant number of studies (11 of 21) in this review defined interactivity as a pattern of communication between learners and/or instructors. This operational definition of interactivity proved most common across the studies reviewed, but also revealed some slight distinctions in focus. A few studies referring to interaction as patterns of communication focused primarily on the amount and directionality of online messages. For example, Tsui and Ki (1996) examined the interchange between students and the instructor in an eLearning context over 16 months that resulted in an explicit pattern of communication, including the common sequence of the student posting questions, the instructor providing responses, and then the student acknowledging the response and sharing ideas with others. In this research, specific directional communication patterns between instructor and students and among peers, as well as evidence of

increasing amounts of messages over time, indicated the presence of interaction.

Other studies included factors of amount and directionality, but also examined the purpose of messages and participant perspectives on interaction. Hillman (1999) identified communication patterns related to the amount, purpose, and mechanism of 52,081 sentences in a course employing CMC. Identifying the purpose of online messages as organizing, lecturing, humanizing, or expressing opinions provided a detailed view of interaction patterns in an eLearning environment. Hillman (1999) advocated that measuring interactivity in research studies involving asynchronous communication should include more than quantitative tallying of number of words or postings in interaction. Patterns of exchanges in this medium need to be situated in context by qualitatively examining the purpose or intention of sentences.

In the only research study using primarily synchronous communication, Paolillo (1999) examined the presence, frequency, and use of specific linguistic features common to synchronous discussion (e.g. use of single characters in place of a word such as "r" for the word "are" or "u" for the word "you"). The researcher examined log files for the relationship of social patterns to the use of the common linguistic features in synchronous communication. This interpretation of interactivity involved the amount and frequency of use of specific linguistic or characteristics and their relationship to the communication pattern of social exchange.

Vrasidas and McIsaac (1999) explicitly and broadly defined interactivity as "reciprocal actions of two or more actors within a given context" (p. 25). The researchers operationalized this definition by determining how often each student communicated with the instructor and, in turn, how often the instructor communicated with the student. In addition, data on teacher and student views of interaction were collected, ultimately determining that multiple factors such as structure of course, class size,

feedback, and prior experience with CMC influence interaction.

It is clear that many researchers view interaction as a function of the amount and pattern of communication among participants in eLearning environments. However, some researchers extend this definition to include the quality, complexity, and depth of communication evident in these learning contexts. For example, Hara, Bonk, and Angeli (2000) measured the amount, quality, and cognitive depth of student discourse. Reviewing the number of times students referred to other student comments, they found that these patterns of communication became more complex and frequent over time. Using content analysis methods, this study reviewed contributions for evidence of social cues and level of cognitive skills, including inferencing and judgment among others. Conclusions of the study illustrated an assessment of quality of interaction through the classification of the majority of messages judged to reflect an in-depth cognitively elaborate level.

Also examining complexity of online exchanges, Sotillo (2000) investigated the syntactical differences between asynchronous and synchronous modes of communication. In this study, interaction is perceived as discourse function (e.g. requests, responses, greetings, etc.) and level of language complexity represented by evidence of subordinate clauses. Synchronous communication was determined to be more interactive, demonstrating a type of discourse mimicking face-to-face interaction. Asynchronous communication was more constrained than synchronous but also more complex when using the above definition of interactivity.

In examining patterns of communication, several studies involving eLearning and interactivity defined the construct within a small group context. Jonassen and Kwon (2000) looked at the amount, function, and patterns of communication in small group problem solving versus face-to-face interaction. Similarly, Curtis and Lawson (2001) identified elements of face-to-face modes of collaboration during

eLearning. McDonald and Gibson (1998) also examined interactivity by determining characteristics and patterns of communication that represented interpersonal needs in a small group involved in an online course.

Also in a small group context, Ahern and Durrington (1995-96) investigated the effects of anonymity and group saliency on participation and interaction in a computer-mediated discussion, and found that anonymity promotes increased participation by students. This conclusion was based on examining variables of visits, messages, words, and time in a computer conferencing environment. More words, longer messages, and additional time spent by small groups who remained anonymous through the use of pen-names indicated increased interactivity over the groups who knew each other. In the studies reviewed so far, conclusions involving the amount of individual and small group participation as well as function, purpose, and quality of messages provide evidence of a definition of interactivity related to patterns of communication among students and instructors in eLearning courses. Although the operational definitions of the construct varied, these research reports represented interactivity as a specific pattern of communication between two or more participants.

### ***Interactivity Defined as Instructor-Learner Communication.***

Two research studies involving interactivity incorporated a focus not on learners, but on instructors. Mahesh and McIsaac (1999) operationalized interactivity as the dynamic of instructor-student communication and the actions of the instructor to encourage communication among students. Instructor time spent on these activities also provided an operational definition of interactivity in this study. Mortera-Gutierrez and Murphy (2000) demonstrated a similar view in defining interactivity through the general practices and strategies of instructors. These researchers concluded that eLearning is dependent on the personal and unique

style of instructors and their activities in an online course as well as institutional and logistical factors.

### ***Interactivity as Social, Cooperative, or Collaborative Exchange.***

Other studies defined interactivity as a form of social exchange, including Lally and Barrett (1999), who determined that socio-emotional discourse provided evidence of interaction. Cooperative engagement with peers and reflection on the views of others in this study represent an alternative view of interactivity. Pena-Shaff, Martin, and Gay (2001) also conducted a study that examined interactivity as social interchange of brainstorming and building consensus among students. Asynchronous and synchronous communication were used in this study, and it was determined that messages that asked questions, answered questions, provided support, clarified ideas, built consensus, and contained social messages were interactive in nature. Asynchronous bulletin board conferencing provided more task-related messages and were more appropriate for self-reflection, while synchronous chat demonstrated more interactivity (evidenced by message act analysis and coded as categories above) and much less task-oriented communication. These studies operationalized interactivity as social, collaborative, activity co-created by student participants.

### ***Interactivity as a Range of Instructional Activities and Technologies.***

Several studies interpreted interactivity more broadly than active involvement by the learner, communication patterns, instructor activities, or collaborative and social exchange. These researchers studied interactivity through a range of instructional activities and use of specific technology delivery mechanisms. As an example, Murphy, Drabier, and Epps (1998) examined instructor-learner communication across different asynchronous computer conferences (e.g. student-moder-

ated, instructional, auxiliary, and metacognitive conferences) contained in a single course. Interactions were distinctly defined in each conference, providing some overlapping definitions as well as unique interpretations. For example, the student-moderated conference provided the largest number of student opinions and responses to peers. The most prominent form of interaction in the instructional conferences was evidenced by providing a response to peers or providing feedback. In metacognitive conferences, the most frequent interaction type was student reflection on the instructional strategies.

Luetkehans (1999) determined that interactivity is most prominent in contexts where multiple strategies and activities, including instructor feedback, collaborative learning strategies, and multiple technology mechanisms encourage student participation. Soo and Bonk (1998), in their Delphi study of distance education experts, also concluded that a range of activities ranked by these experts provide evidence of interactivity in eLearning courses. They found that among the possible types of interaction, asynchronous learner-learner interaction was perceived as the most important type of interaction, and synchronous least important by some experts.

Many different definitions and forms of interaction are present across studies in the educational technology literature. Next, we turn our attention to categorizing the specific types of eLearning interactions found in these studies in order to address the second research question.

### ***Types of eLearning Interactions Found in Studies***

Hirumi (in this issue) presents a taxonomy used to plan key interactions in the design and development of eLearning. This taxonomy is also useful in examining the research related to interactivity. Studies were reviewed for their emphasis on various types of eLearning interactions (see Hirumi's article for elaborated descriptions of levels of interactions). In this

review, studies were found to often include more than one category of eLearning interactions, including learner-self, learner-human, learner-non-human, and learner-instruction interactivity. In many cases, the studies demonstrated a primary focus in one category and a secondary focus in another.

Looking across the research using Hirumi's taxonomy, the majority of studies focused primarily on the learner-human level of interactions. Appendix A summarizes the eLearning interactions identified in each study. Nine of the 21 studies incorporated a learner-learner type of interaction with a focus on the exchange between learners as evidence of interactivity. For example, Hara, Bonk, and Angeli (2000) studied primarily learner-to-learner interaction, noting an increase of times when students referred to each other's messages across the length of the course. Many of the studies that focused on small group activities placed an emphasis on learner-learner interaction as well (Jonassen, et. al, 2000; McDonald & Gibson, 1998; Ahern & Durrington, 1995-96). A learner-learner emphasis was found in studies across definitional categories including research that operationalized interactivity as active involvement (Ahern & Durrington, 1995-96; Kanuka & Anderson, 1998), as patterns of communication (Hara, Bonk & Angeli, 2000; Jonassen & Kwon, 2000; McDonald & Gibson, 1998; Jessup, Egbert & Connolly, 1995-95; Curtis & Lawson, 2001; Paolillo, 1999), or as social, cooperative or collaborative exchange (Lally & Barrett, 1999).

The second largest category of types of interaction appearing in the literature included a primary focus on learner-instructor interaction and a secondary focus on learner-learner interaction. These studies showed an emphasis on communication between instructors and students often delineating and comparing amounts of messages to learner-learner interaction (Hillman, 1999). In these studies, factors influencing interaction were assessed primarily from the instructor's perspective, as evidenced by Vrasidas and McIsaac's (1999)

conclusion that structure, class size, feedback to students, and participants prior experience with CMC are prominent variables related to interaction. In this study, the researchers deliberately excluded learner-content and learner-interface type of interactions, defining the construct solely as a function of learner-human interchange.

A balanced view of learner-instructor and learner-learner interactions was found in the McIsaac, Blocker, Mahes, and Vrasidas (1999) study. Providing evidence of these perspectives, this study concluded that teachers are more concerned about the level of participation and interaction with students in an eLearning course than a traditional one, and that students stated that a lack of feedback from both instructors and their peers contributed to feelings of isolation and dissatisfaction with the course. Patterns of responses between instructors and students were also emphasized in some studies, while providing valuable information on learner-to-learner exchanges (Tsui & Ki, 2000; Sotillo, 2000).

A few researchers chose to focus solely on the learner-instructor type of interaction. Mortera-Gutierrez and Murphy (2000) elaborated on the instructor's role, establishing and defining instructor-learner, instructor-content, and instructor-technology forms of interaction. Mahesh and McIsaac (1999) placed importance on the teacher's perspective and implementation of interaction as determining factor of success in eLearning courses stating "Interaction has to occupy an important place in the design of the course and only the teacher can give it such a status by making it a priority" (p. 266).

Only one study incorporated learner-self interactions encompassing cognitive operations and metacognitive processes of the student. Pena-Shaff, Martin, and Gay (2001) included reflective activities of self-questioning and rationalization as categories in their research analyzing messages for non-interactivity (e.g. demonstrating reflective analysis, subjective analysis, or task-related messages) and interactivity (e.g. asking questions, pro-

viding support, or building consensus). Other studies seem to incorporate the span of all types of interactions presented by Hirumi, as evidenced by Soo and Bonk's (1998) study that asked experts to rank different eLearning activities as most important to least important, eliciting a broad interpretation of interaction.

As can be seen in this report, interaction analysis can be used to classify research studies as well as implemented in design and development efforts. Using Hirumi's framework, major gaps in the literature are revealed. Studies emphasizing learner-learner and learner-instructor types of interactions are prominent, while studies that include assessment of intrapersonal forms of cognitive and meta-cognitive interaction are few. This review did not reveal any studies focusing on learner-non-human interactions, nor did the review reveal research that demonstrated the higher-level learner-instruction interactions that incorporate a meta-level strategy or deliberate arrangement of events. This finding gives credence to Hirumi's (this issue) call for a more grounded approach in designing or incorporating key interactions. This type of analysis needs to be integrated into research involving

interactions in eLearning contexts as well as instructional development. Only when distinct definitions of interactivity are delineated and types of interactions are clearly identified will the research in this area progress to provide informative practical guidance for the eLearning design and development community.

### ***Common Research Outcomes***

Jackson (1980) asserts that a good review of research that identifies contradictory results should explore reasons for the differences and determine what the body of research, taken as a whole, reveals and does not reveal about the topic. This review has discussed the contradictory definitions of the construct of interactivity, establishing categories that seem to define interaction in a similar way. To bridge research and practice, it may also be useful to summarize common research outcomes and delineate recommended instructional strategies and activities suggested by the results. Table 4 lists common research outcomes found in this review. Related instructional activities are found in the fourth column of Appendix A.

TABLE 4  
A Synthesis of Research Outcomes related to eLearning, Computer-Mediated Communication and Interactivity.

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- An increase in student participation (or interaction) is evident as eLearning courses progress
  - Instructors perceive the frequency of communication with students as an indicator of interaction
  - Course structure, class size, feedback and experience in eLearning contexts are perceived as factors influencing levels of interaction
  - Social exchange and patterns of communication are perceived as exemplifying interaction
  - Cooperative or collaborative activities are perceived to foster interactivity
  - Peer participation and instructor feedback are perceived as significant elements of interactivity
  - Explicit patterns of interaction can occur between instructors and students and among students
  - High levels of interaction need to be modeled by the instructor for students
  - A cooperative goal structure requiring students to interact with other students can promote interaction
  - eLearning courses are learner-centered but demand higher levels of commitment and responsibility from students
  - Interpersonal issues and creation of an initial welcoming atmosphere are important in eLearning courses
  - Different technologies can support different kinds of instructional activities (or interactions)
  - A single technology delivery mechanism can support varying types of instructional strategies or interactions
  - Asynchronous and synchronous forms of communication afford different instructional strategies
  - Small groups using asynchronous communication demonstrate task-directed behavior in problem solving
  - Similarities are found between online and face-to-face interaction
  - The instructor's role is significant in promoting interactivity and indicates a change in role from face-to-face instructional contexts.
  - Instructors' teaching style and background impacts course design, structure and level of interactivity implemented
  - Instructors report that they spend more time (interacting) in an eLearning course than in traditional courses
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## CONCLUSION

As Cooper (1985) states, the goals of a literature review are to form general statements from multiple instances, resolve conflict between ideas, and create a common linguistic framework. This review examined literature related to computer-mediated communication, eLearning, and interactivity to promote better understanding of the operational definition of interactivity across multiple research studies, determine the types of interactivity present in those studies, and synthesize the research outcomes to facilitate the transfer of research into effective practice.

The research synthesis strives to present the state of knowledge concerning relations of interest and to highlight important issues that research has left unresolved (Cooper, 1998). The current review highlighted gaps in the literature based on mapping interaction analysis to the body of studies in educational technology related to interactivity. In addition, the review revealed the following additional areas of research that are needed to clarify and broaden studies that focus on interaction. As indicated by the multiple interpretations found in the literature, common operational definitions of interactivity are needed for future research related to eLearning and computer-mediated communication. It is hoped that the categories of interaction that emerged from this review will provide additional clarity on this issue.

The majority of located research studies focused on asynchronous communication, indicating that additional studies involving synchronous communication would enrich the literature. Multiple studies provided emphasis on learner-learner and learner-instructor types of interaction. Research incorporating intrapersonal aspects of interactivity or learner-self types of interaction, such as metacognitive or cognitive processes, would also improve the literature base. Other types of interactivity included in Hirumi's taxonomy were minimally represented in the review, including learner-instruction and most learner-non-

human types of interaction (learner-content, learner-interface, and learner-environment). Additionally, determining what constitutes non-interactivity, as Pena-Schaff, et al. (2001) attempted in their study, would provide clarity of definition of interaction in future studies.

This review also revealed more research employing case study methods than any other research method, and only a few true experimental studies. Many researchers capitalized on qualitative methods, using content and discourse analysis along with descriptive data to conduct their study. Although a range of research methods was apparent, the most robust studies seemed to incorporate a mixed methods approach and examine multiple courses across longer timeframes. For example, McIsaac, et al. (1999) examined six course sections across a period of three years in their study capitalizing on interpretivist analytic induction and descriptive methods. Tsu and Ki (1996) provided a longitudinal view across 16 months of learner-instructor interaction using experimental and message analysis methods. Studies that incorporate multiple course, longitudinal data and use of innovative methods, such as hierarchical cluster analysis, are often the exception in research related to eLearning, however these studies may offer rich information for the field.

Many studies examined the amount and frequency of communication representative of interaction. As Hillman (1999) indicates, there is a need to move past merely "counting" the number of times participants communicate in an eLearning course and provide more information for the field related to the quality of that interaction. Hara, et al. (2000) and Jonassen and Kwon's (2000) studies are representative of the rich results that can be gleaned from a mixed method research approach.

Many researchers and theorists lament the quality of current research related to educational technology and online courses (Phipps, 1999; Reeves, 2000). Only by reviewing current research, establishing common terminology, and better defining the activities that represent interactivity, will research in this

area improve. It is hoped that this review moves the field closer to clarity in classifying the many operational definitions of interactivity, and provides insights that benefit a connec-

tion between research and practice related to computer-mediated communication, eLearning, and interactivity.

### ***APPENDIX A. DEFINITION OF INTERACTIVITY, ELEARNING INTERACTIONS AND INSTRUCTIONAL STRATEGIES OF REVIEWED STUDIES***

<i>Citation</i>	<i>Operational Definition of Interactivity</i>	<i>Elearning Interaction(s) Represented</i>	<i>Instructional Strategy/activities Suggested by Results</i>
Hillman (1999)	<ul style="list-style-type: none"> <li>Patterns, amount &amp; purpose of online communication</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Provide opportunity for students in a eLearning environment to participate in organizing, lecturing, expressing opinions &amp; creating a welcoming atmosphere</li> </ul>
Pena-Shaff, Martin & Gay (2001)	<ul style="list-style-type: none"> <li>Asking, answering questions, supporting or clarifying ideas, building consensus and other social messages</li> </ul>	<ul style="list-style-type: none"> <li>Learner-self</li> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Use asynchronous conferencing for reflective activities including self questioning and rationalization, synchronous activities are appropriate for social, brainstorming communication but not for building arguments and consensus.</li> </ul>
Vrasidas & McIsaac (1999)	<ul style="list-style-type: none"> <li>Reciprocal actions of two or more actors within a given context eliminating learner content and learner-interface interactions</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Consider course structure, class size, feedback to students and participants prior experience with CMC as influencing factors on interaction</li> </ul>
McIsaac, Blocher, Mahes, & Vrasidas (1999)	<ul style="list-style-type: none"> <li>Teacher time and purpose online</li> <li>Amount and goals of student participation including getting help, sharing content-related information, submitting work, discussion of or exchange ideas, or socializing</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>eLearning courses can benefit independent, motivated learners, those who want an alternative to FTF instruction, and previously unserved populations</li> <li>Incorporate significant feedback to avoid student feelings of isolation.</li> </ul>
Tsui & Ki (1996)	<ul style="list-style-type: none"> <li>Asking questions, providing responses, acknowledging responses, sharing ideas</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Expect pattern of interaction with students asking questions, instructor responding and acknowledging response, as well as sharing ideas</li> <li>Expect peer communication to increase over time in eLearning environment</li> </ul>
Lally & Barrett. (1999)	<ul style="list-style-type: none"> <li>Socio-emotional discourse including committed engagement with and reflection upon views of others demonstrating a co-operative mode of work</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Encourage social exchange in eLearning environments</li> <li>Create a co-operative goal structure where students need to interact with other students to achieve their goal</li> </ul>
Mortera-Gutierrez & Murphy (2000)	<ul style="list-style-type: none"> <li>Practices and strategies of instructors</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> </ul>	<ul style="list-style-type: none"> <li>Instructor's style influences interaction as well as characteristics of the learners, the institution, costs, distance delivery technologies, instructional design model applied, instructional strategies used course content and materials.</li> </ul>

<i>Citation</i>	<i>Operational Definition of Interactivity</i>	<i>Elearning Interaction(s) Represented</i>	<i>Instructional Strategy/activities Suggested by Results</i>
Mahesh & McIsaac (1999)	<ul style="list-style-type: none"> <li>The dynamic of communicating with students and encouraging communication among students as well as time spent on these activities</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> </ul>	<ul style="list-style-type: none"> <li>Instructors should expect to spend more time on an eLearning course than a traditional one</li> <li>A higher level of commitment can be found through requiring students to participate online taking responsibility for their learning</li> <li>Teaching style, personal philosophy and background of teacher impacts the course design, student-teacher interaction in an online course.</li> </ul>
Murphy, Drabier & Epps (1998)	<ul style="list-style-type: none"> <li>Learner actions of sharing ideas, discussing experiences and clarifying concepts, etc.</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> <li>Learner-instructor</li> </ul>	<ul style="list-style-type: none"> <li>Computer conferences support different types of interactions</li> <li>Learners are aware of communication patterns and off-task behavior in eLearning environments</li> </ul>
Soo & Bonk (1998)	<ul style="list-style-type: none"> <li>Range of activities ranked by distance education experts and including many of the defined eLearning interactions</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> <li>Learner-instructor</li> <li>Learner-other</li> <li>Learner-self</li> </ul>	<ul style="list-style-type: none"> <li>Asynchronous learner-learner interaction is perceived as the most important type of interaction</li> <li>Three top ranked categories are asynchronous interactions (learner-learner, teacher-learner &amp; learner-materials)</li> <li>Three lowest ranked categories were synchronous learner interactions (learner-learner, learner-self, learner-materials).</li> </ul>
Luetkehans, (1999)	<ul style="list-style-type: none"> <li>Multiple strategies or activities including instructor feedback, collaborative learning strategies and providing multiple technology mechanisms for participation</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> <li>Learner-instructor</li> <li>Learner-content</li> </ul>	<ul style="list-style-type: none"> <li>Interaction or collaboration amongst participants should be encouraged by including participatory, discussion-based activities</li> <li>High levels of interaction need to be modeled</li> </ul>
Hara, Bonk & Angeli (2000)	<ul style="list-style-type: none"> <li>Amount, quality and cognitive depth of student discourse</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Interaction patterns became more complex and interactive over time but were dependent upon the quality of the initial questioning.</li> <li>Increase in the number of times students referred to other students' comments across course.</li> <li>Structuring students experiences in a computer conferencing environment provides opportunities for in-depth, higher level processing.</li> </ul>
Sotillo (2000)	<ul style="list-style-type: none"> <li>Discourse functions (e.g. requests, responses, greetings, etc.) and complexity (ideas represented by subordinate clauses)</li> </ul>	<ul style="list-style-type: none"> <li>Learner-instructor</li> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Different modes of CMC are quantitatively and qualitatively different</li> <li>Synchronous discussions are highly interactive and demonstrate more student control</li> <li>Asynchronous mode affords more complex language than synchronous and primarily demonstrated student responses to teacher requests</li> </ul>

<i>Citation</i>	<i>Operational Definition of Interactivity</i>	<i>ELearning Interaction(s) Represented</i>	<i>Instructional Strategy/activities Suggested by Results</i>
Jonassen & Kwon (2000)	<ul style="list-style-type: none"> <li>Amount, function and patterns of communication in group problem solving tasks</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Small groups in problem solving task may find communication in computer conferencing more satisfying and higher quality than in face to face groups</li> <li>Using computer conferencing, groups demonstrate more task directed and focused communication better reflecting the problem solving nature of the task</li> </ul>
McDonald & Gibson (1998)	<ul style="list-style-type: none"> <li>Characteristics and patterns of interpersonal communication</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Interpersonal issues most important in beginning of course involving CMC</li> <li>Groups using CMC have similar interpersonal issues and stages as face-to-face groups</li> <li>Instructors should model openness or expressions of feelings and self-disclosure and solidarity demonstrations of affection, acceptance or warmth in CMC</li> </ul>
Jessup, Egbert & Connolly (1995-96)	<ul style="list-style-type: none"> <li>Frequency and function of contributions in brainstorming using an electronic group support system</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>In brainstorming with electronic tools, learners are most productive when they interact frequently (every 2 minutes).</li> <li>Learners may need lead time to think about ideas prior to brainstorming in groups using electronic tools</li> </ul>
Ahern & Durrington (1995-96)	<ul style="list-style-type: none"> <li>Length of communication and time online</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Anonymity encourages the participation of individual members</li> <li>Under the protection of anonymity, the comments became longer and students averaged more time engaged with material.</li> </ul>
Curtis & Lawson (2001)	<ul style="list-style-type: none"> <li>Number and form of communication in Web course authoring tool</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Analysis of participants online postings reveals behaviors associated with collaborative learning in face to face situations including planning, seeking help and feedback</li> <li>Differences include a lack of challenge and explain cycles that are thought to characterize good interchanges in face-to-face tutorials.</li> </ul>
Paolillo (1999)	<ul style="list-style-type: none"> <li>Presence and frequency of use of specific linguistic features in synchronous communication</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Highly structured pattern of social interaction indicating strong ties with specific language use</li> <li>Different vernacularizing linguistic variables may be localized in different areas of a social network</li> </ul>

Citation	Operational Definition of Interactivity	Elearning Interaction(s) Represented	Instructional Strategy/activities Suggested by Results
Kanuka & Anderson (1998)	<ul style="list-style-type: none"> <li>Type and number of messages related to phases of knowledge construction in asynchronous learning environment</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> </ul>	<ul style="list-style-type: none"> <li>Asynchronous forms can provide reflection and exposure to multiple perspectives but may not promote application of new knowledge</li> <li>Instructor or subject matter expert needed to draw out new concepts.</li> </ul>
Zhu (1998)	<ul style="list-style-type: none"> <li>Patterns and amount of participation and relationship to role in electronic discussion</li> </ul>	<ul style="list-style-type: none"> <li>Learner-learner</li> <li>Learner-instructor</li> </ul>	<ul style="list-style-type: none"> <li>monitor, implement and revise student roles in conferencing</li> <li>require instructor approval for introductory and synthesis comments</li> <li>recruit other students for facilitator and mentoring roles each week</li> <li>pair advanced students as mentors to novices</li> <li>promote issue-based introductory questions allowing students to develop own ideas and thoughts.</li> </ul>

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