# Interaction in Distance and Online Education: A Research Review

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# Introduction - Why Interaction is Important

Interaction in education has long associated with involvement, engagement, persistence, enjoyment and increased learning outcomes, as I outline in this paper. In many ways interaction actually creates and embodies the educational experience. I echo the famous American education philosopher John Dewey who argued strenuously that in a learning or educational experience, interaction occurs between an individual, objects, and other people. However, we must also guard against a mechanistic few of interaction and acknowledge the critical role and the mind-set of the participants in that interaction. The educational experience becomes what it is because of this transaction between an individual and what constitutes his or her environment – and both of these variables- the individual learner and the environment are very complicated and multi-facetted. Therefore this review too, has many components.

In fact the effect of interaction has been so pervasive that Rose (1999) declared that the concept of interactivity “has become so firmly entrenched within the discourse of educational computing that it is a truism to say that instructional software is interactive and that interactivity promotes learning, and a kind of heresy to dispute it” (p. 44). Despite predominance of both research and practitioner writing about interaction, there is need to continuously update and synthesize the voluminous literature on a continuing basis so that developments and insights might be shared and most importantly forged into practice by educators. In this paper I attempt to synthesize the literature emerging from online and distance education that focuses on interaction. I rather arbitrarily and for the sake of parsimony, delimit this review to research that was published in peer reviewed journals between 2004 and 2014, which I attempt to overview. I then adapt a more narrative review by providing commentary and exemplar studies that demonstrate the research lens as focussed on important and emerging pedagogical and technical issues in interaction research.

The paper is focused and organized under headings that emerged as most common topics both from past interaction study (such as the major actors interacting) and those emerging from recent literature (such as interaction patterns revealed through network analysis). The review is not comprehensive, as to do so would tax myself and the readers, but I hope the systematic and narrative gleaming of the literature is of value in setting new research goals and agendas and in improving online teaching and learning practices.

# Definitions of Interaction

Given the voluminous writing and interpretations interactivity it is perhaps no surprise that Rose (1999) noted that in education technology the concept of interaction is “… a garmented, inconsistent and rather messy notion…” (p. 48). To attempt to de-clutter the concept I begin with a brief discussion of the definitions of interaction found in the literature. From Ellen Wagner (1994) we find that a useful definition of interaction must meet three basic criteria.

1. It must be grounded on clear and operational definition that is based on relevant theory and research.
2. It must not be restricted by replicating face-to-face methods that ignore the increasingly powerful interactions that are mediated and take place between human and machine actors
3. It must lead to empirical assessments and measurement of effects on a variety of educational outcomes including learning, motivation, persistence and creativity.

Given these requirements I turn first to standard dictionary definitions. The Webster Meridian dictionary (online) defines interaction as “ mutual or reciprocal action or influence”. This definition though broad, does not specify the actors, their numbers or any intent of the interaction. In earlier works (Anderson, 2003b) I have used Wagner’s 1994 definition “reciprocal events that require at least two objects and two actions. Interactions occur when these objects and events mutually influence one another” (p. 8). This definition has value in that it does not specify that the objects interacting must be either human or non-human, since both human and machine interactions characterize online and distance education activity. I also still like the notion of reciprocity in that typically when humans interact and when some types of non-human interactions or machine to humans interactions occur, each influences the other. However, in education we also have a long tradition of learning happening without reciprocity of effect as when a student reads a text book, watches a video or in most cases listens to a lecture. One can argue that in an era of analytics, recommender systems and recordings of traces of learner behaviours that are left as learners interact with content, they will be influencing that content. For example, certain resources may become more popular by revealing to learners the amount of use or recommendations from other learners. To leave the door open to this type of normally one-way effect, without denigrating the importance in education of true reciprocal interaction, I will define *educational interaction as activities between two or more agents designed to support and enhance learning of one or all agents.* I use agents in the sense often used in computer science publications to describe both human and non-human participants in the interaction.

# Research Questions

This study is an attempt to scour from the extensive literature on distance and online learning the ways in which interaction, in its many formats, both effects and defines formal education delivered online or at a distance. Three research questions guide the study:

1. What are the focuses, and major results of research on interaction in the past decade (2004-2014)

2. Are there shifts in focus, methods in interaction in DE research over the past decade.

3. What are promising research tools, techniques that are proving useful in further study and exploration of interaction in online learning contexts?

# Method

The initial plan for this review was to systematically investigate the literation on interaction in online learning by using tools from Google Scholars. We (myself and Athabasca University gradate student Lorne Upton) used a strategy to find articles that :

* were published in the last 10 years – including and after 2004.
* had the words interaction in the title or abstract and "online education" OR "distance
* education" OR e-learning OR elearning
* Were from peer reviewed articles or conference proceedings
* Had the highest number of citations (references by others)

Our strategy was only partially successful. We ended up realizing that interaction is such a large and pivotal topic in that literature that our strategy returned a number of articles that failed to specifically address interaction (false positive) and conversely we later found articles that were very important and relevant, yet had failed to appear in our search (false negative).

We did however find the strategy useful for scanning the immense literature available and the strategy alerted to us to many pivotal research results.

We coded each of the 152 studies revealed by our search strategy by the type of research methodology employed (table 1)

Table 1. Primary Research Method in Selected Articles

|  |  |  |  |
| --- | --- | --- | --- |
| Research Methodology | | # of articles | % |
| conceptual | | 59 | 38.8 |
| case study | | 57 | 37.5 |
| survey |  | 13 | 8.5 |
| experimental | | 6 | 3.9 |
| theoretical | | 1 | 0.65 |
| meta-analysis | | 6 | 3.9 |
| action research | | 5 | 3.2 |
| content analysis | | 4 | 2.6 |

As the table shows the largest number of studies were classified as being conceptual in nature in that they used or developed a new conceptual frame to discuss or analyze interaction. This high percentage demonstrates the value placed by researchers and practitioners on developing conceptual lens to assist us in dealing with relatively new educational phenomena and related data sources. On the other hand, it is somewhat discouraging to realize the number of articles with little or no empirical data to back up arguments or ideas presented. Case studies are equally high in number, this is partly a reflection of the lack of funding for more sophisticated research and the interest by researcher/practitioners in documenting and learning from the contexts in which they are practicing or are available to them.

We also noted the educational context from which data for the research was conducted or ideas were specifically related (table 2).

Table 2. Education Level of Selected Articles

|  |  |  |
| --- | --- | --- |
| Student Level | Number of articles | % |
| k-12 | 2 | 1.3 |
| post-sec | 71 | 46.7 |
| all | 38 | 25 |
| workplace | 6 | 3.9 |
| unspecified | 35 | 23 |
| total | 152 |  |

The highest number of articles was focused on postsecondary contexts. This is perhaps unsurprising given that most educational researchers are employed as teachers in postsecondary institutions. This also points to a weakness in the research literature when attempting to project results into particular contexts of K12 and workplace training. We also not that 25% of the interaction articles were more general and not specifically related to any given learning context.

Given the challenges of systematically reviewing the literature, we reverted to a more narrative analysis based upon primary themes that we found in the selected literature and those derived from our own subjective analysis of the field, gained through our 20 plus years as an active researcher and author.

I first turn to the major theoretical models employed in interaction research in online and distance education.[[1]](#footnote-1)

# Models of Interaction

Many theorists have proposed models by which both researchers and practitioners can better understand, define and manipulate variables and interpret results from interaction interventions. Xingfu & Xinyu (2009) overview the main theoretical models of interaction beginning with those common in traditional distance education and ending with more network centric theories - including some of those discussed below.

## Value of a model

In many areas of intellectual pursuit it is useful to deconstruct complex phenomena and constructs to create simplified models. The model retains and highlights critical variables or components of the construct while eliminating superfluous, extraneous variables or needless complicating detail that tends to obscure and restrict deeper understanding. To be successful the simplicity and the heuristic value of the model must of course be greater than the value of examining the phenomena in it’s unrefined complexity. In distance and online education authors have tended to develop two types of models of interaction. The first focuses on the actors in the interaction, the second on the educational function or value of the interaction.

## Interaction Classified By Actors

Michael Moore was the first major distance education theorist to differentiate the types of interaction based upon the actors involved. Moore’s (1989) article differentiated between the three important types of interaction that involve students (student-student, student-teacher and student-content). Given the importance of student interaction to student learning, it is perhaps not surprising that Moore’s model is the most commonly cited in the literature. In this review we found that many of the most cited studies on interaction find it of value to separate (either conceptually or methodologically) amongst these three student-centered types of interaction and thus we carry that these through to new developments in technology and pedagogy later.

Following from Moore and realizing that there are three major actors involved in educational interactions, (students, teachers and content) Anderson & Garrison (1998) extrapolated and discussed the remaining three types of interaction possible. The first of these was teacher-teacher interactions. Many studies have found that the role of effective teachers, in formal education contexts, is critical to student learning, persistence and engagement (Bolldén, 2014b; Restauri, 2006; Schallert et al., 2014; Wilson & Stacey, 2004). Thus, interactions that support teachers in being effective actors are very important.

With the arrival of social media, distributed communities of practice and increasing online capability it is no surprise that teacher-teacher interaction, most notably for the purpose of professional development has become an important and cost-effective means used to supplement and in some cases replace face-to-face professional development activities. Of particular interest is the capacity for online interaction to span regional, national and intercultural barriers that have inhibited opportunity for teachers to engage in either formal or informal professional development activities. In addition, online professional development may be episodic (taking place for a limited period of time), similar to a face-to-face conference but for even more powerful effect, they are often continuing, allowing teachers opportunity to learn, to practice, to reflect and to share developments over an extended period of time. For an example of the former, one can see the continuing sponsorship for over 20 years online of the Teachers, Colleges and Communities annual conference, for the later an excellent example is the ITForum Mailing list that has for over 20 years as well, supported wide ranging discussions and announcements to thousands of educators located around the globe.

The second form of interaction detailed by Anderson and Garrison was teacher-content interaction. The capacity of teachers to create, to find, to retrieve and most importantly to share content has increased exponentially during the past decade. First there was interest in creating, tagging and sharing learning objects (Bannan-Ritland, Dabbagh, & Murphy, 2002; Downes, 2003; McGreal, 2004). It soon became apparent that there was a need to clarify ownership of these objects and most importantly for both teachers and creators to be easily able to license their copyright objects using a variety of restrictions. This need was met by the evolution of Creative Commons licensing that reported having increased licensing from 50 million objects in in 2006 to 882 million objects in 2014 ("State of the Commons," 2014). Despite this popularity there are continuing challenges in helping educators to develop an open educational culture and practices (Hannon, Huggard, Orchard, & Stone, 2014) that takes advantage of the opportunity provided by open education products in particular and more broadly in open education scholarship.

The final form is the increasingly important interaction between and amongst content itself. This non-human interaction, in which one form of content updates, reconfigures or repurposes another is at the basis of adaptive learning, real time environmental sensors and monitors, recommender systems, and a host of new semantic web type applications. Much of the development of content-content interaction is at research stage, however we can expect it increase in both on-campus and online forms of education.

## Learner Interface Interaction

Less well covered in the literature are interaction models that include interaction between the learner and their learning context - sometimes referred to as learner-interface interaction (Hillman, Willis, & Gunawardena, 1994). Although it can be argued that the ease of use of the interface can significantly influence speed and ease of learning, all forms of distance learning, by definition, involve user-interface interaction and so we do not cover this model extensively as a separate entity. However, media theorists continue to conduct experimental studies to determine at what point the richness of interface (graphics, audio, video animations, high definition etc.) are associated with enhanced motivation and learning. For example, Alseid, & Rigas (2009) conducted an experimental study showing significantly enhanced learning and significantly decreased learning time for students presented with video, avatars and audio presentation as compared to those who read the content presented only by text and graphics.

## Vicarious Learning

Finally, some authors have expanded the interaction models to include vicarious forms. In this type of interaction (similar to Bandura’s (1977) social learning theories) students learn merely by observing other student (or teachers) interact with content or with each other (Sutton, 2001). Unfortunately, this vicarious learning is often associated with passive learning and usually fails to achieve the type of active learning deemed necessary for efficient and effective learning. This inefficiency seems to have been born out in the few empirical studies that have been focused on the learning outcomes associated with vicarious student interaction (Kawachi, 2003; Tulley & Lucas, 1991). However, despite the lack of evidence for direct results I see continuing interest in the learning that can happen from observing others while they model learning behaviours – a practice increasingly common in online worlds. In particular studies do point to value of spending time observing other students (lurking), even if learning results are generally lower than those achieved by active learners (Beaudoin, 2002).

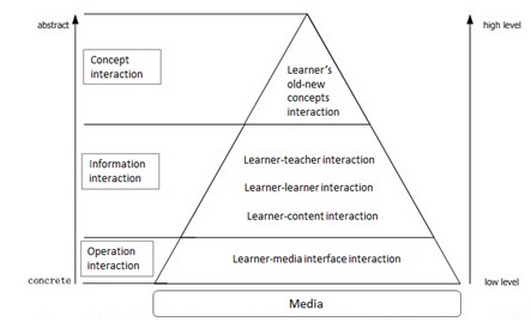
Each of these models of interactive learning is useful in that they allow researchers and teachers to segment and focus on particular components (in the above cases, actors) of the very complex processes between learners and the contexts within which their learning takes place.

## Interaction Classified By Function

Next, I look briefly at interaction models that focus not so much on the actors involved in the interaction but on the role or value of the interaction.

Although little known outside of the Chinese speaking world, Chen’s (2004) hierarchical model of Interaction (see fig. 1) is well known and the subject of many studies published in China. Her model, as is appropriate to one designed to be used by online and distance educators is based upon a medium which delivers and supports instruction. The base and precursor to any meaningful interaction is that between learner and media, which Chen refers to as Operation Interaction. This is very similar to Hillman, Willis, and Gunawardena’s (1994)’s Learner- Interface interaction. The second form of interaction in Chen’s hierarchical model is designed to support the exchange of information. At this level the necessary prerequisite knowledge is usually transferred from the teacher to the learner, but this can also be buoyed by student-student and student-content interactions. Finally, deep learning occurs at the highest level of the model in which conceptual interaction occurs leading to conceptual growth and new understanding.

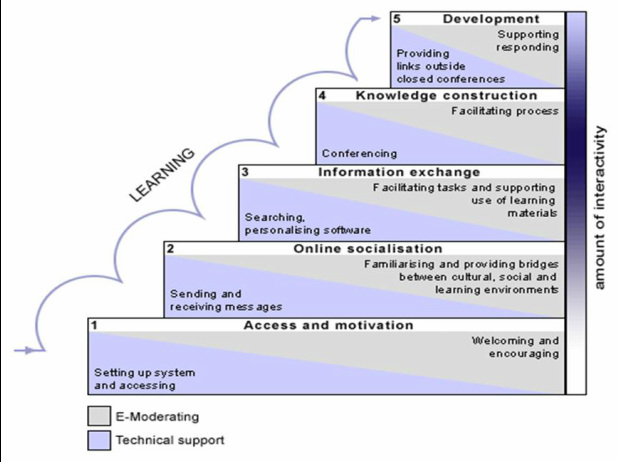
Figure 1 Chen (2004) Hierarchical Model for Instructional Interaction



Oliver and McLoughlin (1999; 1997) explore not the actors, but the functions of the interaction in which they participate. They classify (and count the incidences) of social, procedural, expository, explanatory and cognitive results or intent of particular human (students or teachers) interactions. Oliver and McLoughlin (1999) include in their chapter interesting correlations with student-teacher, student-content and student-student interactions.

The 5 stage e-moderation model (figure 3) by Gilly Salmon (2000) provided what has become a very popular model describing the role of interaction especially in regard to those initiated by the moderator (a form of online teaching). As seen in Figure 3, at the right is an increasing degree of interactivity that progresses from merely getting access and motivation (similar to Chen’s 2004 interface interaction). The interactivity then leads to increasingly complex learning interactions that culminate in a rather confusing “development stage”. Although to us it is unclear what or who is being developed and why the other stages are not developmental as well, the model does illustrate the increasing complexity and function of the interaction as learning progresses in an online course.

Figure 2. Salmon's (2000) e-Moderation Model

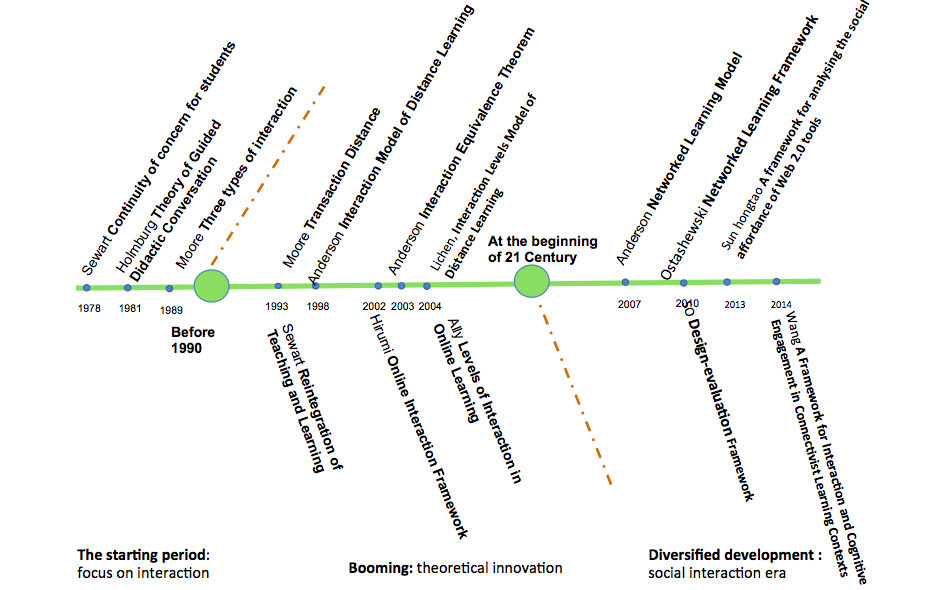


## Chronological Ordering of Interaction models

Wang, Chen and Anderson (2014) in a valuable review of interaction models in online learning present a chronological overview of model development (fig. 3). From it we see steady progression of interaction models in the literature and a marked increase in recent years. We also see a move from interaction focussed on student-teacher (Holmberg, 1989; Keegan, 1990) tutoring models to that on peers and group learning (Moore, 1989); (Garrison & Shale, 1990) to those based on networking models (Anderson & Dron, 2011; Siemens, 2007)

.

Figure 3. Chronological overview of interaction theory and model development from Wang & Chen (in press)



In general interaction models that have guided both research and practice have focussed either on the function of interaction or upon the actors. Both approaches have proven useful, but also remind us of the complexity involved in teaching and learning- either in classrooms or at a distance. The actions, motivations and intent of the actors are important, but no less so than the contexts and environment in which they act.

I turn next to ways in which these interactions have been measured.

# Assessing Interaction

Given the predominant role played by interaction (in its broadest sense) by all generations of distance education pedagogy, it is essential that both researchers and practitioners are able to measure interaction and to study the relationship (both causal and correlational) between interaction and a variety of outcomes. In the next section I overview recent work in this area.

This area was covered in a broad sense by Dennan (2008), in which he explored current best practices for both assessing (for student grades) and evaluating (for research proposes) the most common mode of interaction currently supported in online learning. This is the common threaded discussion, which has been both the inspiration and the focus of a large number of interaction studies in online lining. Dennan’s study briefly overviews the most common assessment strategies and provides short examples of each- thus serving as a useful introduction to this section.

## Participation measures and learning analytics

Perhaps the most common and easiest way to measure interaction is to count the number of interactive activities engaged in by actors- primarily students and teachers. These tallies are then often compared to output measures such as course completion rates, re-enrollment rates and learning outcomes. More recent developments (often a major component of learning analytics suite) have been to use the absence of such traces (indicating non interaction on the part of the actor) as a trigger for an intervention. These can be things such as the triggering of a telephone call from the teacher or student counselor in case of student non-interaction or from the Dean in case of teacher non-interaction!

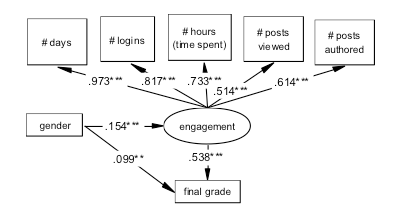
Participation (as evidenced by interaction traces) is necessary for obvious reasons, but research based on participation often suffers due to a number of challenges. Most importantly measuring the number of logins, screens viewed or even posting of messages does not of itself indicate that learning has taken place. However, as seen by the examples below there seems to be enough correlation evidence mounting to suggest that these measures can be taken as surrogates for learning, though researchers must be careful not to assume that participation necessarily is equivalent to learning. A second problem is determining the unit of analysis. Which is a more accurate correlate of learning – the number of logins, the number of messages posted, the length of the messages, the time spent logged in, the cognitive level evidenced in the posting? There are no simple answers to either the analysis or the choice of unit to analyze.

The degree of interaction (at all three levels of student-student, student-teacher and student-content) by students has also been shown to be an accurate predictor of motivation and eventual completion of online courses. Munoz-Organero, Munoz-Merino & Kloos (2010) found positive relationships between the student activities within a learning management system and indicators of student motivation and positive course completion. A final caution for researchers is to acknowledge that highly motivated students naturally interact most extensively in the course and are likely to successfully complete the course. Thus, frequency of interaction may be correlated but may not be a casual factor in successful learning outcomes.

In an extensive series of studies of over 400 courses with both hearing and hearing-impaired studies Long, Marchetti & Fasse (2011) found that not only that the most interactive students had better learning outcomes, but that the design of the course (to increase interactions) effected course outcomes. The “study looked at academic achievement of students enrolled in 432 online courses based on the amount of online interaction that occurred in the course. Students enrolled in online courses with more interaction outperformed students in online courses with less interaction. Students … said that online interaction was important to their learning, and findings … confirmed the validity of these perceptions with higher GPAs for more interactive courses.”

More recently Lowes, Lin, & Kinghorn (submitted for review) used LMS analytics to investigate the relationships between various forms of “student engagement” – a variety of interactions, with final grade among 800 online high school students. Figure 4. shows the strong statistical relationship between all the interaction measures and final grades, with moderate differences between males and females.

Figure 4. Path Relationship between 5 components of Engagement, Gender, and Final Grades from Lowes, Lin and Kinghorn (submitted for publication)



Moving beyond measurements of the number of interactions leads to studies trying to measure the content and function of that interaction.

## Content Analysis

Content analysis of the interactions has become an important methodology associated with interaction studies and especially those in online contexts. Online education, for perhaps the first time in human education history allows recordings of the interactions with almost trivial ease and at almost no cost. This accessibility of this research fodder has inspired many researchers to study especially the recordings of texts inputted by teachers and students, but also voice interaction, nature of key-clicks and haptic motions (such as eye or mouse movements) engaged in by interactive actors. The methodology however hides many complex research issues. As (Rourke & Anderson, 2004; 2001) pointed out in their review of 200 content analysis articles, issues of reliability and most importantly, of validity are legion especially in quantitative content analysis methods. For example, there is considerable controversy over what the unit of analysis (the things to be counted) should be in participation studies. The easiest way to resolve this unit of analysis categorization is to rely on manifest variables that are easy measured (such as turn taking, grammatical delimiters such as paragraphs, number of words, speech acts etc.) However, many of the most important variables in education are latent (expressions of understanding, feelings of competence, expressions of humour etc.) and thus very hard to measure with scientific reliability. An examination of content is useful for determining major activities and concerns of participants and allows researchers to determine and count incidents of behaviours which they interpret or treat as dependent variables. However, this methodology can be reductionist in terms of coding what is most easily coded, rather than what is most educationally important. Further, we lack standardized coding schemes in which data from multiple experiments can be compared (De Wever, Schellens, Valcke, & Van Keer, 2006).

A number of researchers have developed coding schemes that were developed to guide and

Systemize content analysis to increase reliability and to allow comparisons of analysis across different content and cases. The most popular of these is was developed by Garrison, Anderson and Archer in conjunction with development of the Community of Inquiry (COI) model. In their initial work Garrison, Anderson and Archer developed coding indicators for each of social, teaching and cognitive presence and were able to calculate a rating for each presence in a course.

Canadian researchers Faye, Crawford and Ally (2001) developed the Transcript Analysis Tool (TAT) that guides researchers to code text interactions into one of the five categories: (1) questioning, (2) statements, (3) reflections, (4) interpersonal coaching and scaffolding, and (5) references and authorities. The TAT system has shown to be better than many other coding schemes at producing reliable results, partially because the unit of analysis is strictly defined as a single sentence and every sentence is coded (Fahy, 2006). In a recent study Schwier & Seaton (2013) used the TAT to compare transcripts found in examples of formal, non-formal and informal learning environments.

The Interaction Analysis Model (IAM) developed by Gunawardena, Lowe & Anderson (1997) was designed specifically to generate evidence of knowledge construction from a constructivist pedagogical perspective. Although used extensively by researchers, in an insightful 2014 article, one of the original developers Gunawardena and her colleagues (Lucas, Gunawardena, & Moreira, 2014) reflect on challenges of the low levels of knowledge construction identified in elearning courses.

As expected, these initial coding schemes are now often combined with other qualitative and quantitative tools to overcome some of the inherent deficiencies in any single research method. See for example Gutierrez‐Santiuste and Gallego‐Arrufat (2014) study that combines COI transcript analysis with temporal phases of the interaction.

Finally, a number of researchers have coded elearning interactions based on a variety of speech acts or systems that classify levels of argumentation. For example, Jeong (2006) concluded that “Overall, these and other findings from exploratory post-hoc tests show that conversational language can help to produce patterns of interaction that foster high levels of critical discourse, and that some forms of conversational language are more effective in eliciting responses than others.” P. 1

Despite the challenges with transcript analysis methods often noted by researchers, quantitative analysis remains a popular research method for measuring both latent variables such as critical thinking (Belcher, Hall, Pressey, & Kelley, 2014) and more explicit educational variables such as off task activities (Abedin, Daneshgar, & D'Ambra, 2014). These challenges and potential solutions are addressed succinctly by Donnelly and Gardner (2009).

The time-consuming nature of hand coding, challenges of scaling and reliability issues have given rise to a number of systems that attempt to automate these process. In particular at least three researchers have developed systems to code transcripts based upon the Community of Inquiry model. The earliest example was by McKlin, Harmon, Evans & Jones (2002) used neural network techniques to classify messages into the four levels of cognitive presence. Corich, Hunt, & Hunt, (2012) developed a system that first aides in manual coding of transcripts and then uses the results to create algorithms based on word matching that then can be used to automatically analyze additional transcripts. Their Automated Content Analysis Tool (ACAT) produced remarkably accurate coding as compared to hand coded transcripts. Finally, Kovanovic, Gasevic & Hatala (2014) have developed a number of tools, again focusing on indicators of cognitive presence as defined in COI model. In our work developing the original schemes for coding the COI model, we found that identifying cognitive presence levels was the most challenging of the three COI presences to code. Thus, the work automating this task has particular significance. Automated content analysis, as a component of a learning analytics suite, give promise to real time analysis of online interaction allowing for interventions and also allowing for use at scale such as needed in MOOCs.

Finally studies are dealing with some of the inherent challenges of quantitative transcript analysis by triangulating the results with more qualitative results (Belcher et al., 2014).

For example, Greenhow, & Belbas (2007) use qualitative techniques (interviews, focus groups and thematic coding of transcripts) to develop a model for online instruction based on activity theory.

## Micro-ethnography, Phenomenology and Other Qualitative Interaction Research

A range of qualitative research methods have been employed to study interaction and its effect in online learning. These techniques examine the interaction and a wide variety of contextual data (often including surveys, interviews and field notes as well as text analysis of conversations) to provide thick description (Geertz, 1994) of both the interactions and the contextual surroundings in which they evolve. Although creating challenges associated with limited observations, identity and privacy issues, online contexts provide unique insights and enhanced transparency not found in face-to-face world. In an overview of ethnography research in online contexts Garcia, Standlee, Bechkoff & Cui (2009) note that “ethnographers must learn how to translate observational, interviewing, ethical, and rapport-building skills to a largely text-based and visual virtual research environment” and in the process deal with privacy, security and rapid evolution of life in online contexts.

Ethnographic and other forms of qualitative research require extensive and in-depth study and thus are often limited to a small number of subjects. From extensive data collection, observations and observational insights the researchers hope to gain and explicate a deep understanding of the learners online experience. As an example, Waltonen-Moore, Stuart, & Newton (2006) present a case study that centers on participants enrolled in a web-based, graduate level professional development course. They use grounded theory techniques including constant comparative methods to analyze the threaded discussion board interactions, interviews with the instructors, and formative and summative course evaluations. They coded and extracted themes and categories to create a model for the stages of online group development experienced by students. Five stages of online group development were identified: (a) Introduction, (b) Identification, (c) Interaction, (d) Involvement, and (e) Inquiry. Waltonen-Moore, Stuart, & Newton argue that awareness of these stages of experience will help both researchers and teachers to emphasize with and develop support for online learners. In addition, these stages provide implications for teaching and learning online.

Bolldén (2014a) provides an example of phenomenological research study of online interactions. She uses the perspectives of ‘practice theory’ to make the argument that understanding teachers’ deliberate efforts to recreate “body and bodily traces online” is critical to sustaining online presence and developing certain types of learning activities.

## Dialogue analysis

Dialogue analysis is based on language studies and tries to explicate the value and the nature of interactions in online contexts. This method examines the dialogue itself for indicators of linguistic terms and holistic meaning making within the interactions. These methods include conversation analysis and discourse analysis. These techniques require close, detail-oriented analysis of the transcripts and like other content analysis tools is challenged by reliability and validity issues. Although generally quantitative, it can also leave room for more interpretive understanding of the interactions and can be highly interpretive

Recent developments using artificial intelligence and other sophisticated programming techniques are developing ways that these interactions can be automatically coded by machines. Obviously, this has great potential for this type of research, as hand coding is both tedious, time consuming and often unreliable. As an example Samei, Keshtkar, Rus, & Graesser (2013) propose a system that automatically (with capacity to override by humans,) classifications of educational interactions based on speech acts.

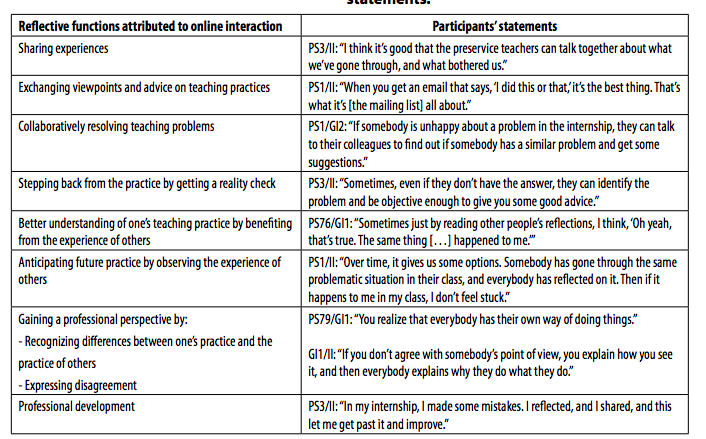
Table 3 Speech Acts and examples from Samei, Keshtkar, Rus and Graesser (2013)

|  |  |
| --- | --- |
| Speech act category | Example |
| Expressive Evaluation | Your stakeholders will be grateful! |
| Greeting | Hello! |
| Meta Statements | oh yeah, last thing. |
| Statement | a physical representation of data. |
| Question | What should we do? |
| Reaction | Thank you |
| Request | Please check your inbox |
| Other | ed is tough, no doubt. |

## Analysis of Reflective Assignments

In this method of studying interaction students are given reflective assignments such as daily or weekly learning diaries or end of course reflections. They are often challenged to reflect on the role of interactions (with other students teachers and content) in enhancing or facilitating their learning. With sufficient prompts, researchers can trigger student examples of sense making, error correction, deeper understanding and other latent results of interaction that are difficult to undercover using other research techniques. Typically this research uses both qualitative and quantitative techniques to analysis the resulting assignment submissions and from these gains rather deep insights into student perceptions of online learning. A caution though, these assignment artifacts are in some ways artificial in that they are compulsory activities and may reflect more what the student thinks the teacher wants to hear, as opposed to their owned beliefs. An example of this study of reflective assignments was published by Collin, & Karsenti (2013) in Table 4. They identify the reflective functions attributed to the online interaction that are documented with references from reflective assignments.

Table . Reflective functions attributed to online interaction (Cllin and Karsenti, 2013)



## Perception Studies

Likely the most common type of study in online education uses some form of learner perception as the dependent variables to measure impact of interaction- the independent variable. Perceptions studies are much easier to design and implement than more empirical studies based upon variables such as learning outcomes. All research methods suffer to some degree from some degree of method bias Podsakoff, MacKenzie, & Podsakoff, (2012). However, perception studies suffer from more from validity issues in that subjects have a tendency to report positively about themselves and to validate what they believe the researcher wants to know.

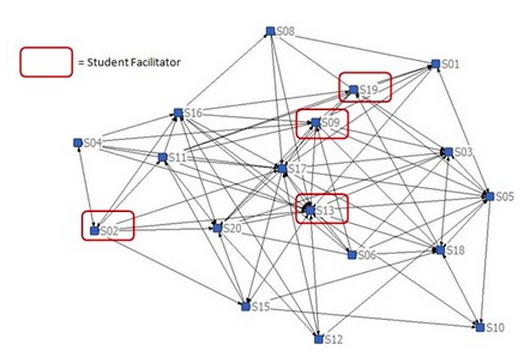
To at least partially address these challenges, many perception studies triangulate evidence of participant perceptions by combining surveys with interviews and user logs. For example Sasseville (2015) used both a control groups study and perception data to study the user perception of the value of tutor interaction and the quality of the user interface.

## Network Analysis

Recent interest in network pedagogies and associated research techniques has produced a number of studies in which interaction is examined using social network analysis (SNA) techniques. SNA calculates and displays both graphically and computationally the relationships between actors in educational encounters. By displaying the relationship among and between each participant, often extracted through contributions within the network or at least by their viewing of network interactions the degree of centrality, connection and the direction of interaction can be calculated and visualized.

For example, in a study based on Community of Inquiry ideas, Shea, Hayes, Smith, Vickers et al. (2013), study revealed a new type of interaction revealed by degree of in and out centrality and perceptions of prestige amongst the members. They called this Learning Presence- the amount of self-regularity confidence held and expressed by learners. Figure demonstrates the use of social network analysis by indicating the number ties that connect (based on both responding to and initiating interactions).

Figure . Social network graph of student connectivity and centrality (Shea, Hayes, Smith, Vickers, et al. 2013)



Social networks provide a new way to support and enhance both student-student and student-teacher interactions. In a study undertaken in Libya, Ballera, & Radwan (2013) found “Quasi-experimental results indicate that there is an increase on the cognitive level of students at different level while qualitatively reveal that it helps deepen learning, memory and have freedom to express opinions and lessen pressure and increase communication and socialization”

Gillani, Yasseri, Eynon, & Hjorth (2014) studied interaction patterns by learners in optional MOOC discussions forums. They noted first the interesting graphs that can be drawn using network analysis to show the interactivity and the most critical nodes (actors). They also note the vulnerability of the learning network to the presence of a limited number of key communicators. But of particular interest is rich interactions that seem to emerge not at network level, but at smaller emergent groups much like the affinity groups described by Gee (2000). They argue “modularity in MOOC forum networks appears to “trap” information in small learner groups. This finding is important as it highlights structural limitations that may adversely impact the ability of MOOCs to facilitate communication amongst learners that look to learn ‘in the crowd’”.

Figure 6. Network Connections in two Coursera Moocs, showing importance of key nodes from Gillani, Yasseri, Eynon, & Hjorth, I. (2014)



## Assessing Community Using Survey Results as Indicators of Interaction

Rovai (2002)’s developed his Classroom Community Scale to determine its validity and reliability for use with university students taking courses at a distance via the Internet. The 20-item Classroom Community Scale measures sense of community in a learning environment. Initially, data was collected from 375 students enrolled in 28 different courses, offered for graduate credit via the Blackboard e-learning system by a private university. They concluded that the Classroom Community Scale is a valid and reliable measure of classroom community and that this instrument yields two interpretable factors, connectedness and learning. The first construct is connectedness to other students, that presence is enhanced with opportunities to interact and get to know and to trust other students. The second construct is learning, many of items of which are associated rich opportunities to interact with teacher, content and other students that in turn lead to a sense of enhanced learning. This instrument has been used as a dependent variable to measure effect of a variety of student-student and student-teacher interventions.

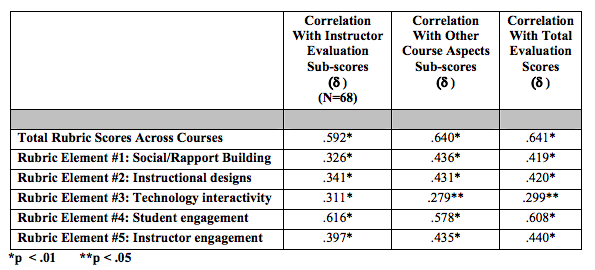
The challenges associated with content analysis, resulted in the need for to a more efficient data collection tool for researchers using the Garrison et al.’s 2001Community of Inquiry Model. In Arbaugh et al. (2007) created a 40 item questionnaire based on the indicators identified by Garrison et al, that constitute the three presences of the community of inquiry model. In subsequent studies the instrument psychometric properties were evaluated with students from multiple institutions (Arbaugh et al., 2008). The COI questionnaire has proven to be a robust and efficient tool that provides data on the COI based upon students’ perceptions, rather than on researcher analysis of the online content. The revised instrument, as well as many resources associated with the use of the COI model are available to researchers at https://coi.athabascau.ca/

## Rubrics Assessing Interaction In Courses

One of the challenges of assessing interaction for grades in online learning, is that much student behaviour is invisible to teachers. Often activities such as reading, browsing, following links, doing online exercises and other activities which do not result in postings or comments are neglected. There is a small but growing body of evidence suggesting that nonvisible and visible interactions are highly correlated and that assuming that a student who is not actively posting, may not be accurate. There may be a host of reasons including time pressures, redundancy (other students have made the same point), language or cultural issues that preclude active posting, but not necessarily learning (Kui, 2013). Thus, certain caution must be exercised by all teachers when assessing students by analysis of their online contributions.

Nonetheless, for many students and teachers, online learning is still a novel educational context and a great deal of uncertainty can exist (with generally negative results on learning) when actors are unsure of the methods by which their performance will be assessed. Thus the interest in rubrics that can be used by students to guide and self-assess their contributions and by teachers to actually undertake evaluations. Rubrics or structured criteria upon which teacher evaluations will be based, add transparency and at least a perception of reliability and validity to teacher assessment of learner knowledge.

Rubrics can also be used by researchers to systematically measure interaction in an online course. For example, Roblyer, M. D., & Wiencke, (2003) have designed a rubric to assess and encourage interactive qualities in distance courses. The rubric helps research by assigning a score based on observed behaviours (or transcripts) of four elements. Social/Rapport-Building Designs for Interaction; Instructional Designs for Interaction; Interactivity of Technology Resources and Evidence of Learner Engagement. In later work, Roblyer & Wiencke (2004) added a fifth dimension to the rubric – Evidence of Instructional engagement - and provided evidence of positive correlations between concepts in the rubric and students and teacher perceptions of value and inveracity in the course (Figure 6).

Table . Correlations between course evaluation scores, subscores, and rubric scores from Roblyer & Wiencke (2004)

## Control Group Studies

Control groups studies sit at the pinnacle of respectability and quality evaluation by many scientifically orientated educators and researchers. This is because the control group study is the research method that can most easily be used to ascribe causality to educational studies. If it was possible to control and hold identical all other contextual variables, then a valid argument can be made that the differences (independent variables) between the control and the experimental group, is responsible for any change. Of course, in educational practice in real contexts, it is nearly impossible to control all variables and the cost of even attempting doing so are usually prohibitive. Thus experimental, control group studies of interaction in education are relatively rare.

However, I briefly note one control group study. Mahle, (2012) conducted a short term (one session) experiment on student-student interaction with two treatment groups and a control group. The highest level of interaction condition had proactive levels of high student-student interaction in the learning design. The design added decreasing amounts of student-content interaction at lower two levels. The results showed significant increases in learning outcomes and motivation at the higher levels. However, the very term nature of the experiment, makes generalization of results to multiple week courses problematic.

## Meta-analysis

The lack of funding and many logistical challenges associated with control groups studies results in both a small number of quality control studies but also studies with limited numbers of participants - thus increasing the challenge of being able to report significant differences between control and treatment groups. Partially to meet the challenge of small numbers and to aggregate the results of many small studies, meta-analysis techniques have been developed. A number of well-known meta-analysis studies have been done to compare online (or distance) achievements (Bernard et al., 2004; Shachar, 2010), effectiveness (Machtmes & Asher, 2000) (Sitzmann, Kraiger, Stewart, & R., 2006) satisfaction (Bourhis, Burrell, & Mabry, 2002) and persistence rates Bernard, 2004 #1070} to those delivered on campus.

In addition to these general distance education/classroom comparisons two meta-analysis have looked more deeply at the role of interaction in online contexts and as importantly compared online studies to other online studies with different instructional designs or strategies. In the first Bernard, Abrami, Borokhovski, Wade et al. (2009) used studies with different levels of inveracity and compared achievement results. The aggregated results of the 74 studies showed that increases in levels of interactivity were associated with increases in student achievement. In a later meta-analysis control groups studies were compared based on actors (student-teacher, student-student, student-content) partially to test Anderson’s (2002) equivalency theory. As in the 2004 meta-analysis the 2009 work also showed a significant improvement in achievement when the interaction treatment levels were increased. Interesting is that the least gains were found when student-teacher interaction was increased, with more substantial increases associated with both increased student-student and especially student-content interaction. As I will discuss later, this has implications for cost effectiveness as student-teacher interactions are generally the most expensive to maintain, while student-content interaction is the most scalable.

Most recently Bernard and his Concordia University team published the results (Borokhovski, Tamim, Bernard, Abrami, & Sokolovskaya, 2012) of a meta-analysis in which two types of student-student online interaction were compared. In these studies treatments in which students participated in designed activities in which high levels of student-student interaction were required were compared to studies in which the context allowed for interaction to occur (often in synchronous or asynchronous conferences) but instructional activities did not mandate that interaction. The results favoured designed interaction treatments over contextual interaction treatments.

Researchers interested in the techniques, challenges and opportunities associated with meta-analysis research and especially as used in distance education contexts are strongly encouraged to read Robert Bernard’s *Things I Have Learned about Meta-Analysis Since 1990* (2014).

## Multiple research methodologies

As has long been argued by proponents of mixed method research, triangulating the results from different methods can and often does produce more meaningful and valid research results. In an interesting study Lowes, S., Lin, P., & Wang (Lowes, Lin, & Wang, 2007) compare the interaction results from the same online learning conferences using four different methods. These were learning analytic data from the LMS, network analysis of interaction, content analysis and sequential analysis (which posts led to what type of further posting). Lowes, Lin & Wang find value in all four methods not only for the researcher but potential application by practitioners.

# Interaction Research Problems

***Measuring cognitive processes.*** Although hardly unique to educational researchers, the measuring of internal mental processes with accuracy, validity and reliability is a challenge for online education research. Often researchers are forced to measure the easily measured. For example to study recall after a short period of time or use perception data such as students perceived value or extent of learning, rather than more direct measurements. These problems are not unique to online education research, however the separation of students, teachers and researchers over space and sometimes time exacerbates the problem.

***Definitional concerns.*** As can seen by much of the earlier discourse in models, interaction research is challenged by definitional concerns. Latent subjects such as critical thinking, motivation, community and ‘presence’ must all be arbitrarily defined and then measured using variables that are very often constructed by the researcher(s) themselves. This leads to confusion and inability to compare or aggregate results. Fortunately, as access to research works of others through especially open access publishing expands, the opportunity for researchers to build upon, replicate and confirm definitional variables in enhanced - though still a challenge.

***Units of Analysis.*** As noted and especially in content analysis research selection of the unit of analysis can be challenging. Research shows a long history of controversy and research conducted using a host of grammatical, continual, meaning and technical definitions of what components and size of interaction to study. Obviously researchers who use units that are easily and reliably identified are better able to compare and contrast their results with other researchers.

***Low response rates.*** I have noticed in our own work a distinct downturn on the percentage of student responses when conducting online research. This first became apparent when the response rate from the traditional end of class survey plunged from near universal response, when the teacher (or their assistant) stood at the class door on the last day of class collecting forms, to a notice from the LMS that it is time to complete the end of class survey. Some strategies to increase these rates include making completion a course requirement (for marks), awarding grades, adding lotteries or other incentive for completion, multiple requests, personalized requests and assorted other campaign tactics. None of these have proven particularly successful and low rates remain a problem for researchers (Dommeyer, Baum, Hanna, & Chapman, 2004). Certainly the novelty of completing surveys’ online has ended. Finally the ease with which researchers can create and distribute online questionnaires may have resulted in students and teachers suffering from survey fatigue.

An interesting approach to combat this lack of response challenge is to use micro survey’s throughout a course. Again since these are easily created and distributed, student incentive to complete a short 3 or 4 question survey may be hirgehr than an omnibus survey at course end. These micro survey’s could also be built into an online course, and completion of the survey could be included to give evidence of having completed each module. This technique is nicely illustrated by Young Hicks, Villa-Lobos & Franklin, (2014) in which short and rapid feedback from students is used (with positive results) to enhance teaching and social presence, through student evaluation of instructor created videos.

***Interaction outside of “official channels”.*** In the early days of online learning, student interaction was largely confined to interactions within the computer conferencing system or the learning management system used by the institution. Thus it was possible for researchers to gain quite accurate measurements and insights into student-student interaction. Today however, students are as likely to use non-institutional tools such as Facebook, Skype, Instagram, Twitter and host of other emergent web 2.0 tools to support their learning. Thus, the researchers job becomes more complicated and the necessity for talking with students to determine the interaction channels they find of use ion their formal education programming.

Anonymity.

Especially associated with student use of informal channels is the issue of anonymity. Obviously anonymity presents challenges to researchers who need to assert that the actor in the interaction is consistently the same person and in educational contexts that their interactive behaviour can be associated with grades, persistence, participation and other personal variables. However, in many social networks that can and do support learners in both formal and informal context text, anonymity is allowed and in some cases preferred by students. Keipi, Oksanen, & Räsänen (2014) in a study of Finnish learners found that anonymity was “positively correlated with both grandiosity, a component of narcissism and low self-esteem. In addition, users with stronger anonymity preference tended to be younger, highly trusting, having strong ties to online communities while having fewer offline friends.” They conclude by arguing for researchers to develop “a deeper understanding of how anonymity effects and attracts users seeking its benefits while also providing new insights into how user characteristics interact depending on motivation”

***Convenience samples.*** The majority of online education currently takes place in postsecondary education and the majority of active researchers are engaged by universities, often teaching and researching in education faculties. Thus, these researchers have relatively easy access to the students enrolled in the programs in their department, faculty and institution. This has resulted in distinct bias in interaction research towards findings that are tested and validated for the most part in postsecondary institutions often with education students and most egregiously with graduate students studying education technologies and online learning. The insights and the data from these select students can be of value, but given the use of online education throughout secondary education, informal and commercial sectors, it is dangerous to generalize results to these disparate populations. An overview of content analysis studies conducted by Maurino (2006) confirms this bias in a study of content analysis of online courses measuring critical thinking. He found that “of the thirty-seven studies reviewed, nineteen studies evaluated classes at the graduate level and eleven at the undergraduate level … two were on a high school level and five were on a professional level.”

***Divergent Theoretical models.***

Much as I have supported the conceptual clarity provided by any of the models discussed above (and others), researchers need to be cognizant of the filtering function that the model casts over the researchers data collection and analysis. These specific educational models or theories can both illuminate and obscure insights form the data. Meyer (2004) presents an analysis of online discussions using four different theoretical frames. Although she notes the value provided by each frame, she also notes the challenges to validity when the research knows and seeks indicators of the coding scheme prior to engagement with the data.

# Relative Impact of Three Student Interaction Types

The labelling of major actors in interaction, gave rise to an interest in comparing the effect of interactivity on other educational outcomes such as completion, satisfaction, learning outcomes. The three student-centric interaction types – student-student; student-teacher and student-content have been most thoroughly studied. Thus, I briefly summarize a few of the major studies measuring the impact of student interactions in online learning. I conclude this section with a brief overview of Anderson’s (Anderson, 2002) Interaction Equivalency Theory.

## Student-teacher Interaction

The characteristic that most distinguishes formal education from informal and non formal education is the presence of a teacher. The teachers’ role in online learning has many components all of which are manifested in various types of student-teacher interaction. Going back to the familiar Community of Inquiry model, we see teaching presence defined as “the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes.” (Anderson, Rourke, Archer, & Garrison, 2001) p. 5.

Functionally the COI model explains that teaching presence is made of three interactive activities:

* design and organization: This includes preliminary interactions and networking with students, colleagues and other professionals that assist the teacher is chartering and creating a learning path for students to follow
* facilitating discourse: Originally the online world was almost exclusively text-based, and thus facilitating was largely a process of stimulating and annotating text based student learning conferences. Now however facilitation includes effective use of a variety of multimedia in both synchronous and asynchronous time
* direct instruction: Direct instruction is the means by which the teacher uses their specialized knowledge to assess students, correct misconceptions and clarify confusing concepts is the function that differentiates teaching from group facilitation

Early work on online interaction focused on the easily measured - the conversation or transcript analysis of student-teacher interaction. However, we soon realized that not all of the student-teacher interaction is manifest in the conferencing transcripts. In particular student-teacher interaction takes place in private face-to-face or mediated interactions, students engage with other students or with colleagues in the workplace who may take on a teaching role and finally student-teacher interaction takes place in the assessment process that marks all formal education. Wolsey (2008) studied that the individual student-teacher interaction that takes place in feedback on written assignments and list nine types of feedback interaction. All of these types were perceived by students as having some value, but student-teacher interaction providing correction on content, affirmations and copy editing were perceived as most useful. Interesting as well was that none of students preferred feedback summarized at the ending as opposed to seeing the feedback embedded in the assignment.

As noted from the COI model, teaching presence requires efforts to facilitate interaction and in the process help to create a community of inquiry. Rovia’s Sense of Community (SoC) (2002) model expands the list of activities performed by teachers to develop and support the mergence of a SoC in an online course. Shackelford, & Maxwell (2012) studied perceived value of seven types of student-teacher interactions by over 300 online students. They concluded “the interactions that are most predictive of SoC include instructor modeling, support and encouragement, facilitating discussions, multiple communication modes, and required participation. Instructor modeling was found to offer the greatest yield to instructors as a balance between effort and benefit”.

The recent literature also contains a limited number of articles demonstrating the effect of lack of effective student-teacher interactions. Muhirwa, (2009) studied videoconferencing courses delivered in sub-Sahara Africa to groups of students distributed across a number of sites and supported by local tutors. Besides the expected technical problems especially related to the students ability to interact with the teacher, they noted the teacher’s lack of both capacity and training to teach effectively using this medium. One of the most common problems using real time video interaction is the assumption made by both teachers and students that this model of online learning is really the same as classroom teaching. They neglect both the technical and the pedagogical challenges and opportunities associated with developing teaching presence online – even in synchronous contexts.

Much as the literature notws the importance of student-teacher interaction, it also easy to over-emphasize the role of student-teacher interaction in online learning. Obviously teachers have a vested interest in ensuring their own importance in the educational transaction and have the power to insure that students both listen too (follow up quizzes) and respond (marks for participation). Secondly, students have been conditioned by years of classroom study and in many cultures by strong sense of respect for teachers and their interactions and to highly value their role in both online and campus teaching.

In a cautionary study, Drouin (2008) found that “SoC is fostered mainly through communication between students, and that instructor student interactions may not necessarily foster students' sense of community in an online environment.” She also reported that “The findings suggest that SoC is not necessarily an essential component of online classes” since the SoC was not related to achievement, retention or intent to take more courses. These results underlie the need to insure that interaction expectations are clear and met, such that a misalignment does not occur between students and teachers as to both the required and the desired level of interaction in online learning. Much as it is the antithesis of much online learning design based upon social constructivist pedagogies, many students can and do learn with minimal student-teacher interactions.

Murphy and Fortner (2014) conducted studies over six weeks of student postings in asynchronous discussion groups. The teacher initiated conversations in all groups, but in the control groups, the teacher did not add any additional posts, where as in the experimental group the teacher participated in both discussions and responses. The posting where evaluated for quality using a rubric. The researchers found no significant difference between control and experimental groups in terms of the quality of student posts. However, there were significant differences in quantity of postings. The higher number of teacher contributions was correlated to a decrease in the number of student contributions. This study suggests that not only is student-teacher interaction the most expensive, but it may, in some circumstances, inhibit student- student interaction as well.

All of the interaction possibilities I examine in this report are to some degree affected by the media used to convey them. Decreases in cost and increasing availability of synchronous web conferencing has resulted in its increased use in online education. For example Peacock, Murray, Dean, Brown, Girdler & Mastrominico (2012) in a study using synchronous communications report that the synchronous web conferencing “required them to re-think the design of the learning environment, re-visit how they facilitated discourse and re-examine their communication skills especially with regard to feedback on student performance” Other web 2.0 tools are also increasingly used to support-student-teacher interaction. For example Harper (Harper Jr, 2005) argues that the inherent self-disclosure that seems to accompany blog use, may have value in enhancing student-teacher interaction.

As expected studies by Liu, & Cavanaugh (2011) showed that both time logged in and the number of logins were positively associated with student achievement scores in online secondary schools. However the researchers also reported “that teacher comments had signifi­cant effect in only 3 out of 15 courses is surprising for the researchers in this study. More study is needed on the form and content of teacher comments for insightful explanation.”

The studies above and others are showing that student-teaching interactions are important but not always critical component of online learning. As most interaction studies show, the relationship between students, content and teachers is complex and altering any one of these interaction sources has effect on the others.

I next turn to a brief review of recent studies of student-content interaction.

## Student-content Interaction

In his seminal 1989 article, Michael Moore underlined the essential role of student-content interaction in any form of higher interaction. He wrote that learner-content inter-action is “a defining characteristic of education” and “without it there cannot be education” (p. 1). Since 1989, very significant capabilities and affordances of media have changed and expanded. In this brief section I note a few examples of the increasing capacity of student-content interaction.

I include in our discussion of learner-content the burgeoning development of “smart environments” in which various inanimate features of the online environment are enabled to provide guidance, hints, traces etc to others.

In a provocative study, Kuo, Walker, Schroder, & Belland (2014) used a regression model to calculate the relationship between student satisfaction and the three student interactions modes. They found significant relationships between student-teacher interaction but a larger relationship between student-content interaction and satisfaction. They concluded that “the results suggest that improvements in learner–content interaction yield most promise in enhancing student satisfaction and that learner–learner interaction may be negligible in online course settings”. In a related study by Chang, S.-H. H., & Smith,(2008) found significant positive relationships between student satisfaction all three student-content, student teacher and student-student. However by far the largest effect on satisfaction was the value placed by students on student-content interaction

One of most exciting developments in student-content interaction is the capacity for the content to configure itself and adapt to student behaviour or queries. Considerable research in computer and learning science is underway to improve the interface between content (as instantiated in computer programs and databases) through use of natural language interfaces that allow a student to interrogate content resources. Yan, L., Ma, X., & Wang (2012) discuss advances in natural language processing, fuzzy logic and semantic reasoning to further these developments. Other researchers (Flynn & Moneypenny, 2013) have been exploring network based, adaptive learning systems. These present particular challenges as the learners move to and from platforms and resources to enhance or even replace learning normally prescribed and presented on an institutional LMS.

Among the popular techniques in this type of student-content interaction research is to use a measurement of a student’s learning style to adapt the learning content. Despite the heavy criticism of learning styles as a meaningful and useful educational construct, the simplicity of measurement and popularity continue. In a systematic review of 70 studies that were undertaken between 2000-2011 using learning styles to adapt content Akbulut & Cardak (2012) conclude with cautionary analysis of this work. They write “The analysis revealed that the majority of studies proposed a framework or model for adaptively whereas few studies addressed the effectiveness of learning style-based adaptively. Scales were used for learning style identification more than automatic student modeling. One third of the studies provided a framework without empirical evaluation with students.“

More promising are studies that generate a learner model, not from scales developed by psychologists but from the student behaviour itself. One such (Hung & Zhang, 2008) approach focuses on data mining to extract student bias and preferences. Other researchers have argued for open learner profiles created in response to explicit choices of students and/or their learning activities (Bull & Kay, 2010). Most importantly open models allow the student to see and sometimes alter the learning profile that is used to adapt the learning content. Other perhaps even more promising study extends the open profile to gather data from multiple learning activities and paths, often from multiple online learning resources and systems (Mazzola & Mazza, 2009). Finally open model advocates note the increase in self control, reflection and awareness that learners gain when being able to continuously monitor their own learning model.

Despite the improvements in student-content interaction, a caution must be noted related to student-content interaction that is unique to formal education contexts. This is the effect of the power that students place themselves under when they enrol in a course. They expect and are expected to interact with content – thus it assumes an importance regardless of its efficacy in learning. To illustrate this Murray, Pérez, J., Geist, & Hedrick (2012) measured the student-content interaction as indicated by the frequency of access to content presented in a learning management system. As expected they found a strong correlation between those who access more content resources and the final grade. However, they caution that “Students clearly tend to access only course materials that they perceive to be directly tied to earning a good grade.” In the emerging network world where open educational resources, MOOCs and hundreds of help and resource site exist on almost any topic, it is very easy for teachers to assign or recommend more content than can possibly be effectively read, much less understood and applied. I concur with Murray, Pérez, Geist & Hedrick (2012) the necessity for teachers “weaving course content into a cohesive, compelling tapestry”, if effective learning is to occur.

The influence of rewards for student-content interaction is a challenge for courses that place high emphasis on this mode of interaction. If student do not perceive a direct connection between student-content interaction (which can of course range from reading texts, to engaging in simulations to tutorials and quizzes) they are less likely to engage with motivation and time necessary for real learning to happen. In an interesting study Grabe, Flannery, & Christopherson (2008) assessed student-content interaction in which students were first given marks for completing online self-quizzes and then later the reward was withheld - with interesting results They found that “ a) students who first received points for completing study questions later made greater voluntary use of study questions, b) less able readers made less voluntary use of study questions than more able readers, and c) less able readers performed better on course examinations when awarded course points for completing a required number of study questions rather than quizzes”. This suggests that at least initially, visible rewards are useful to instil motivation and that different students may respond differently to ongoing, externally motivated rewards.

Finally much as been learned from gaming industry and “serious games” forms of content are becoming more popular and affordable for both online researchers and practitioners. In a meta-analysis of serious games used in education Wouters, Van Nimwegen, Van Oostendorp, & Van Der Spek (2013) found “serious games were found to be more effective in terms of learning (d= 0.29, p < .01) and retention (d = 0.36, p < .01), but they were not more motivating (d = 0.26, p > .05) than conventional instruction methods”.

Finally I turn to student-student interaction.

## Student-Student Interaction

Support and stimulation of student-student interaction is a key component of online learning pedagogies based on social constructivism. The challenges and the opportunities to support, encourage and evaluate student-student interaction have been much discussed in the literature. The variety and continually emerging devices and tools that comprise the online learning environment has stimulated interest in tool and environment construction. In a 2010 article Fadel & Dyson (2010) list types and examples of content enhancements and tools that can be used to support and encourage student-student interaction They summarize the chapter as follows. “This chapter explores the interface design by investigating how placing an emphasis on interaction facilities and incorporating text, images and animation affects students’ experiences of interacting with each other. The overall conclusion is that the interface design can increase the number of interactions and enhance the perceived social presence in e-learning environments.”

As I discussed earlier the series of meta-analysis undertaken by Bob Bernard and his colleagues at Concordia University have consistently shown that higher levels of student-student interaction is associated with learning gains in a host of online contexts and subject matter. However Bernard et al (2009) also warn that their results show high levels of heterogeneity, meaning that although learner interaction is generally associated with learning improvements, these positive results are not found in all studies. For example, Okonta (2010) did an experimental study in which he found no significant difference between online students engaged in rich student-student interactions compared with those with more directed and traditional lecture based interactions. He concluded that adding student-student interaction did not improve the test scores of students in at least this postsecondary, online math course. I suspect that it is not only the design and execution of the planned interactivity that varies but also the subject matter affects the need for and efficacy of interaction.

Similar to the many studies showing correlations between the participation by students in any form of interaction learning results and persistence, Askov and Simpson (2002) found that distance education students who did reach out to others in electronic correspondence were more successful and those who successfully negotiated group activities online found that their abilities to use technology were enhanced.

One of the challenges associated with student-student interaction is the getting to know other enrolled distance students such that trust and capacity to work together is enhanced. From this familiarity grows the confidence to seek and give help and advice from fellow learners. In a study of efforts by students to reveal more of themselves thus creating ‘edentity’, Olsson & Slumpi (2013) examine how completion of profiles (often provided in LMS and social networking software) and other ways for students to make themselves more visible to each other both facilitates and hastens the development of self ‘edentity’ and the capacity to reach out and interact with other students.

One of most compelling reason to support student-student interaction in online learning is it’s positive effect on persistence. Persistence has continually been an issue in all forms of distance education and is almost always lower than in campus-based systems. There are many theoretical and empirical studies both explaining and predicting persistence. Of these, the sense of participation in a learning community and perception of peer support are nearly always noted as significant factors (Hart, 2012). Of note is a large scale (n-=28,700) study by Boston et al. (2009) that used the Community of Inquiry survey to measures students perception of teaching, social and cognitive presence in their courses.  The study calculated the extent to which each of the "presences" is associated with subsequent re-enrolment in a second course. They found that "a total of 21.1% of the variance in student re-enrolment is accounted for by 19 of the 35 CoI indicators. However, all but 0.9% of that variance can be accounted for by just two indicators:

SP 16. Student believe that online or web-based communication is an excellent medium for social interaction.

SP 15. Student believe that I was able to form distinct impressions of some course participants

Those students who believed (and experienced) the web-based environment as a good medium to support social interaction and who were able to form direct impressions of other students, were most likely to re-enrol.

Despite the pedagogical benefits, student-student interaction in the form of required participation in collaborative or cooperative learning activities is not always welcomed by students in online courses. In a survey of student reactions to collaborative learning Capdeferro & Romero (2012) found that unequal work and ‘freeloading” issues top the list of aggravations. They also found that “online learners also identified difficulties related to group organization, the lack of shared goals among the team members, the imbalance in the level of commitment and quality of the individual contributions, the excess time spent on the online CSCL tasks, the imbalance between the individual and collective grades, and difficulties in communication, among other factors leading to frustration”. Their study concludes with a series of recommendations designed to alleviate these student concerns regarding student-student interactions.

The complexity of research in online interaction is illustrated by a 2012 study entitled E-tutorial support for collaborative online learning: An explorative study on experienced and inexperienced e-tutors (Kopp, Matteucci, & Tomasetto, 2012). The study queried the important role of the tutor (student-teacher interaction) in supporting collaborative learning (student-student interaction) and found that the teaching experience level of the online tutor was critical in supporting effective learner-learner interactions. The study concluded “experience in supporting online collaboration seems to be a useful precondition for successfully intervening to stimulate necessary learning activities and to avoid dysfunctional collaborative activities”

After these brief reviews of the three major types of interaction, I turn to a theoretical model that attempts to explain the relationship among the three forms.

## Anderson’s Interaction Equivalency Theory

As the above discussion illustrates there are a large and ever-expanding number of technologies and pedagogical techniques that could be used to support interaction in online learning. It is also apparent that many of these techniques and tools are costly – not only in terms of the necessary hardware and software, but also in terms of the time and energy required of both students and teachers and the resources required to support and train both groups.

I struggled for some time to gain both theoretical understanding and practical guidance related to the challenges of interaction tool and technique selection and support. In late 2003 I had an insight that there likely was no single best type of interaction and that all of the three student centred interaction types share an equivalency.

This resulted in the first thesis of the Interaction Equivalency Theory (Anderson, 2003a)

*Thesis 1. Deep and meaningful formal learning is supported as long as one of the three forms of interaction (student–teacher; student–student; student–content) is at a high level. The other two may be offered at minimal levels, or even eliminated, without degrading the educational experience.*

In other words, quality learning can be designed that focuses primarily or even exclusively on only one type of student interaction. However, I realized that many courses are designed to use all three types of interaction, which led to the second thesis:

*Thesis 2. High levels of more than one of these three modes will likely provide a more satisfying educational experience, although these experiences may not be as cost- or time effective as less interactive learning sequences.*

Thesis 2 suggests that increased interaction may have positive results on a variety of course outcomes, but these improvements will always increase costs and decrease access in a number of dimensions as noted earlier.

Since the publication of this theory in 2003 a number of studies have been done to attempt to empirically or theoretically prove or disprove the two theses. The most extensive of these was the meta-analysis of online interaction conducted by Bernard et al. (2009) and described in the meta-analysis section above. The study was designed “to investigate Anderson’s hypotheses concerning the relationship between achievement and attitudes and the strength of instructional treatments and media (and their combinations), which are intended to encourage different kinds of interaction.” The results gave support to the theory and suggest “that combining (i.e., strengthening) IT patterns affects both achievement and attitudes, but only to an extent. There appears to be no great advantage to adding two *high strength* ITs over one, particularly for attitudes.” And more specifically they found “strong support for Anderson’s hypothesis about achievement and less support for his hypothesis concerning attitudes” attitudes improve more extensive interaction, but at a cost. This improvement in attitude is however consistent with Thesis 2 from the theory.

A steady flow of additional studies and thesis have been published that are based upon the Interaction Equivalency Theory and these have been gathered on a web site maintained by Terumi Miyazoe at <http://equivalencytheorem.info/> Recently, we have been particularly interested in the relevance of the theory to the production of courses and learning resources that can be scaled. Many MOOCs and the type of instructional video produced by Khan academy and on YouTube provide effective learning with a complete absence of student-teacher or student-student interaction as postulated by the Interaction Equivalency Theory (see (Miyazoe & Anderson, 2013).

From this review of both models, actors and components of interaction I turn now to a very brief review of emerging technologies that currently do, or will in the near future, have important impact on interaction in online learning.

# Current Research and Practitioner Developments in Interaction

In this section I very briefly review some of the new and emerging technologies that have particular application and potential to support and enhance learning and teaching in online contexts.

## Student-Teacher Interaction Developments

### Analytics.

As noted earlier, whole disciplines are emerging based on the affordances of tracking and analyzing educational interactions. For example the discussion differentiating the new Society for Learning Analytics and Educational Data mining communities by Baker & Inventado (2014) provides a sense of the growing interest, not only from researchers but also from companies in the rush to utilize ‘big data’. Learning analytics promises to increase transparency such that much interaction is recorded, analyzed and presented in potentially useful forms for teachers, learners and administrators.

### Call Centers.

Much as industry has embraced call technologies and techniques to support customers, educational institutions are also exploring this innovation as a way to both reduce costs and increase availability of learning support. Kondra, Huber, Michalczuk, & Woudstra (2008) argue that the efficiency of the call centre can result in significant cost reductions for online providers, while still supplying high levels of student support. Critics however argue that much of this support is provided by call centre staff rather than accredited, subject matter teachers or tutors. More research is needed to tease out what aspects of student support and student-teacher interaction can be met effectively by call centre employees and which require more personalize attention from academic teachers.

### Wikis.

Wikis comes from Hawaiian words for quick and they allows distributed groups of users to collaboratively create and edit documents. Obviously these have application for student collaborative learning projects. However a very interesting study on use of over 180,000 wikis in US K-12 schools found quite surprising usage. Reich, J., Murnane, & Willett (2012) found “four types of wiki usage: (a) trial wikis and teacher resource-sharing sites (40%), (b) teacher content-delivery sites (34%), (c) individual student assignments and portfolios (25%), and (d) collaborative student presentations and workspaces (1%). The tiny (1%) use for collaborative learning demonstrate quite clearly that tools are appropriated and used in many different ways than originally designed by creators or as installed by administrators (Bijker, 1999).

## Student-Content developments

Serious Games.

The number of applications and use of student-student interaction that is stimulated, regulated and archived is increasing at very high rates (Liu & Peng, 2013). This creates opportunity for considerable research both in effectiveness of the games and issues of adoption including costs, maintenance, teacher adoption etc.

Artifacts and Archives.

A component of learning analytics is the potential to archive student-developed projects and have these serve as learning objects for future students. Besides simple display of these products tools for rating and recommending allow for filtering and selection of objects that are likely to have particular value to individual and groups of students. Kohlhase & Reichel (2008) describe this as ‘social tagging’ - “allowing content to be created, annotated, rated and improved through tagging thus both growing and embedding student knowledge in learning objects”.

Audio and Video Podcasts.

The popularity of user contributed video sites such as Youtube and Vimeo demonstrate that learners can be very active as both creators and consumers of audio and video productions. These videos can be created by teachers, students or commercial parties. Perhaps the highest quality videos are created by institutions and commercial companies such as the Khan Academy or the Open University. In a review of student use of video Kay (2012) found that “key benefits included positive affective and cognitive attitudes toward video podcasts, control over learning, improved study habits, and increased learning performance.” Alternatively, or in addition to using podcasts created by others, teachers now often have access to the necessary tools within their own personal learning environment to create and distribute audio and video podcasts (see (Benedict & Pence, 2012). These productions may also be created by students themselves and used for peer teaching of current and future students (Armstrong, Tucker, & Massad, 2009). Finally, as predicted by constructivist and connectivist learning theory the production itself can be a powerful and effective learning experience for the creator - teacher or student (Maloney, Storr, Morgan, & Ilic, 2013).

Open Education Resources.

Only since the development of Creative Commons licensing have institutions, commercial providers and individual students and teachers had a way to legally distribute for re-use the content that have created. This legal affordance coupled with the decreasing cost for creating, storing, indexing and retrieving content from the Internet has resulted in explosion of free content that can be used to enhance student-content interaction at very low cost (McGreal, 2013). Despite the potential, much effort is needed to develop a culture of openness that motivates users to both produce and consume open educational resources. Finally, there is a need to create and promote policies at multiple governance levels that support and nourish OER production and use (Pepler, 2014).

MOOCs.

It is certainly beyond the scope of this report to even begin to document the spectacular rise and the current use of MOOC courses that are scalable to very large numbers. However, what is key to remember in the context of this review of interaction is that scalability is achieved largely by two key substitutions. The first is that student-teacher interaction is greatly reduced or eliminated and it is replaced by high levels of student-content interaction. This content is produced using a variety of media but the most common and cost-effective method has been to record video of the teacher engaged in either formal or informal lectures. These are routinely complemented with additional content such as readings and references to a variety of external web resources. Secondly, the assessment and feedback from teacher to student is replaced by student-content interaction in the form of quizzes, games and simulations or student-student interaction in the form of peer review.

Many MOOCs rely on high levels of student-student interaction. Given the larger number of students there is need to develop a variety of tools to support these interactions. These include systems to manage peer review of assignment submissions, means to break discussion groups into reasonable sizes and tools to filter and recommend particular student contributions so as to reduce volume and prioritize comments.

Both these substitutions are supported by Anderson’s Interaction Equivalency Theory (Miyazoe & Anderson, 2013).

### Mobile and interface improvements.

Continuing improvements in capability, interface design and affordability of mobile devices in particular afford enhanced opportunities for student-content interaction. Moreover, the improved comfort, access and efficacy of student-content interaction can result in direct improvements in student-content interactions (Kearney, Schuck, Burden, & Aubusson, 2012). However changing interface can also create new challenges. For example, da Silva, Freire, & da Rocha (2013) found that changing the device from a desktop or portable computer manipulated by keystroke and mouse action created different challenges and opportunities from those when students interact by touch on mobile devices. Thus, the need for research to guide the development of student-content interaction if it is to be used across multiple platforms.

### Analytics of student-content interaction.

A relatively new area of interaction investigation makes use of analytic techniques in which traces of student–content interaction are aggregated or analyzed so as to produce signs indicating student use of, endorsement, recommendation or critique of the content. This type of tacit and computational activity is referred to as collective activities by Dron and Anderson (2014). They provide a list of examples using stigmergy, tag clouds, search trails and other examples of analytical techniques to enhance student-content interactions. Fadel & Dyson (2010) provide a list of guidelines for interface design that harvest such learner behaviours to stimulate interaction and optimal learning designs.

## Student-Student Interaction Developments

Collaborative Learning.

There has been continuing development and research on collaborative learning over the past 40 years. As this work moves online and new tools become available there is concurrent need to both enhance skills of learners and teachers to effectively these tools and a need for greater understanding of the challenges and advantages of moving collaborative work online. Merrill and Gilbert (2008) provide insight into techniques for effectively integrating collaborative, problem based learning into courses. These include “(a) facilitating learners’ activation of relevant mental models, (b) demonstrating problem solutions to learners, (c) enabling learner application to the solution of new problems, and (d) facilitating integration into activities beyond the classroom by critique, discussion, and reflection.” The specific challenges and affordances presented by different types of network communication toolsets were explored experimentally by Mason, & Watts (2012).

Perhaps the most intense forms of student-student interaction online can take place in immersive environments where students share, graphic, voice and video interactions as they engage in collaborative student-student interactions online. In a study of massively multiplayer online role‐playing game (MMORPG) that takes place in Second Life, Childress and Braswell, (2006) come to the enthusiastic conclusion that “ improvements in MMORPGs will lead to increased realism and interactivity, blurring the line between the face‐to‐face learning environment and the online virtual learning environment. Combined with this increased realism and interactivity will also be innovative teaching models and new ways of learning.”

### Student-student interaction beyond the classroom.

As briefly noted elsewhere, online education is extending interaction opportunities beyond the classroom - be it a physical classroom on-campus or a virtual classroom in a learning management system. The extension has potentially very valuable results including allowing for and supporting interaction with working professionals, development and support communities of practice, engagement with peers and graduates not currently enrolled and interaction (at very low costs) with subject matter experts. However, this enhanced interaction affordance comes at a cost to research efficacy. Complete recordings of in class conversations offer no guarantee that they have recorded all the interaction engaged in by class members. In addition indicators from learning analytics systems are only able to gather and analyze that subset of interactions that take place within the classroom portion of the learning experience. Thus interaction research will likely need to use multiple methods to ferret out and to measure the multiple ways in which learning is supported and enhanced by student-student interaction.

# Promising Tools to Support Interaction

### Collaborative creation and editing tools.

The Internet hosts a variety of tools (WIKIs, cloud based word processors, drawing tools etc.) that allow both distributed and campus based groups of students to collaboratively work on projects and content creation. A nice example of this increasing affordances for student-student interaction is a study by Carroll, Diaz, Meiklejohn, Newcomb & Adkins (2013) that uses Bandura’s social Learning theories to assess “attentional, retentional, motor reproduction, and motivational processes” of students when using WIKIs in formal courses. Concept maps have also been used for both teaching and learning tools for a number of years. New collaborative and online tools afford students the opportunity at a distance to engage in this form of student-student interaction.

### Instant Messaging.

Instant messaging combines the reflective capability of text-based interactions with the immediacy of real time notifications. This immediacy has the potential to makes students aware of each other thereby increasing the likelihood of student-student interactions. In addition the popular use of instant message in microblogging and social networking sites can greatly increase the visibility and help to build the social capital of participating students. Chen Wang & Morgan (2008) studied the use of instant messaging in an online graduate course and found that students “rated the course significantly higher than their regular classroom courses, with stronger effects on perceptions of student cooperation and active learning” and concluded that “instant messaging may be used as a technique to increase dialogue and thereby reduce transactional distance, especially among students, in an online course environment.”

### Student directed media.

Real time video interaction as supplied by tools such as Skype and Google Hangouts has moved the capability of duo and group interaction from the realm of institutional facilitation and support, to a context in which learners can facilitate and control their own real time meetings. Although I briefly discussed this under earlier revues of student-teacher interaction, these tools are increasing used by students meeting alone, under their own direction. In a study of informal learning by students enrolled in a foreign language class, but also engaging by reading, writing and talking in the foreign language on social media, Sockett & Toffoli (2012) found that “informal learning does not happen in the classroom or according to a fixed timetable, it is not the product of simply creating a more convivial atmosphere in the classroom, and indeed as an impromptu activity it may not be planned by the learner”. And finally they conclude that “that each learner, with his or her specific range of resources and the interactions between them, experiences learning in a unique and personal way. These results offer powerful implications for ways to enhance learning, through support, skill training and encouragement for informal, learner-controlled interaction to find a meaningful place in higher education.

### Study Buddy and Meetups.

Both one of the traditional benefits and a often class driven hidden curriculum of higher education (Margolis, 2001) as been the opportunity to meet others in the process of studying. This has been used as a process top extend elite cultures and social class, but has also been used as a tool by which learners gain new identities and potentially expand their social networks to new friends, communities and networks. Distance education has always had less opportunity for this type of informal usually face-to-face interaction, however this is changing. Internet tools such as Meetup, Google Groups and Facebook (to name a few) provide a means by which distributed learners can meet informally face- to-face or online. Thus, the capacity for creating study groups and for providing informal help to each other now becomes available to online students as well as those in campus groups. Of course, this increase accessibility gives opportunity for imposters and others with devious intent, however the potential to enhance student-student interaction is immense.

These interactions can also be extended beyond the course. In a study of peer mentoring, Ruane, (2014) used content analysis to analyze the between students and recent graduates of a course as peer mentors. They provide evidence of the social integration that results from these informal and supportive interactions between students that can happen outside of formal courses.

I conclude this report with a brief look at the cultural influences that effect interaction in online courses.

# Cultural Issues in Interaction

There has been considerable study on differences in cultural norms, behaviours and expectations among and between students and teachers from different cultural backgrounds. Although most of this study has been done in campus-based universities. It is reasonable to suspect that similar cultural differences are identifiable in online education as well. Gunawardena (Gunawardena, 2014; Jung & Gunawrdena, 2014) has undertaken a number of studies during the past decade and as suspected identified significant cultural differences and challenges - many of which are related to interaction. When online education model is focused on student-content interaction, it is relatively easy to translate or transcribe examples and narratives to reflect local cultural or religious norms. However, when pedagogical model calls for intense collaborative activities, one can expect increased cultural misunderstandings and expectations. For example, in a 2010 study Watson found significant cultural differences in desire for and expectation for increased student-student interaction in conjunction with social constructivist based learning activities between Australian and Indian students. Another study by Shirin, & Islam (2014) describes linkages between Moore’s student-interaction variables in transactional and Islamic teachings “especially as relates to Ghazali’s framework of four rungs of consciousness relates intrinsic motivation to qalb, ruh, aql and nafs. When these intrinsic elements are fulfilled, students are able to reach the highest learning accomplishment namely wisdom (Hikmah) and well-being.”

Since most of the technology is developed and tested in Western contexts- notably those from Silicon Valley in the USA, it is likely that these tools will be adapted by learners and teachers to work more effectively and likely differently in their own cultures. Indeed, we see in some countries (notably China and its banning of numerous social media sights) efforts to both curtail cultural influences of certain external media and the desire to stimulate local development of alternatives. As global educators, we are forced to both accommodate and to open ourselves to alternative viewpoints when deploying or encouraging use of any of these enhanced communications tools and pedagogies.

For those interested in pursuing cultural issues and their effect on online learning, Uzuner (2009) has published an insightful review of 27 studies that each have a focus on these cultural issues. He also “provides methodological insights for researchers who wish to investigate the cultural dimensions of distance learning in future studies.”

# Time Requirements and Rewards for Interaction

From the discussion and research results summarized above, the reader may think that simply adding interaction opportunities and tasks will in itself produce better learning. However interaction has its cost – in student and teacher time commitments as well as technical support. Lack of time to interact regularly appears as a factor that is positively associated with lack of satisfaction and learning (Guan, Tregonning, & Keenan, 2008).

The cost of direct student-teacher interaction as opposed to the efficiencies of earlier broadcast and print technologies and the unfamiliarity of both students and teachers with student-student interaction suggest that interactive web based environments may not (at least in the short to mid term future) meet the needs or the capacities of large and developing countries. Besides challenges of bandwidth and hardware availability, Motik (2008) in a review of the transition from print based to online distance learning in Korea and China argues against the “uncritical application of western distance education technology and methodology in environments that are unsuitable for them”.

From most of the studies reviewed in this study, I can conclude that interaction (amongst many actors) is generally associated with positive cognitive and affective outputs. But is there a point of diminishing return where too much interaction either impairs learning or no longer is associated with improvements? Castaño-Muñoz, Sancho-Vinuesa, & Duart (2013) used data from 17,900 students from three Catalan online Universities and determined that “interaction in online education has diminishing returns”, perhaps suggesting the pragmatic and instrumental nature of many online learners, coupled with time pressures, creates a demand and need for very efficient forms of interaction – not merely quantity.

Interest in use of digital badges has been increasing since the release by Netscape of a standard for creating and sharing institutional or teacher created badges (Carey, 2012). It is hypothesised that the award of badges can be a useful reward or motivation for students to undertake a variety of interactive activities- with content or other students. In a random controlled group study Hakulinen, Auvinen & Korhonen (2015) found that university computer science students who were awarded badges did not differ in final grade marking from those not invited to participate. However they did find that “statistically significant differences were observed in the time used per exercise, number of sessions, total time, and normalized total number of badges. Furthermore, the majority of the students reported being motivated by the badges. They summarize “Thus the use of badges may serve as a relatively low cost incentive and motivator to students encouraging and supporting them in interacting more frequently.”

It has been a frustration of many distance educators to motivate students to engage (especially beginning students) in the interaction options provided. It seems that distance and online students are likely more independent and often less in need or desiring interaction than campus students. In a qualitative study of 20 Australian first time online learners Brown, Keppell, Hughes, Hard, & Smith, L. (2013) report “a disconnection between institutional support services and the majority of first-time distance learners who demonstrated a self-sufficient, lone wolf approach to learning”. This replicates findings by Poelhuber, Anderson & Roy (2011) that showed that only 53% of students in self-paced distance programs desired any type of student-student interaction.

Thus, it seems that distance education institutions should provide opportunities, but be careful not to make interaction obligations so onerous that they dissuade students from engaging. Or as Norwegian researcher Morten Paulsen is famous for noting that we need “compelling but NOT compulsory” interaction opportunities.”

# Conclusion

This study has attempted to a survey a vast amount of literature and types of interaction. It is thus merely an overview. From it the reader can conclude that topic of interaction is both complex and fascinating. Much research has been undertaken in the last decade, but much more remains to be done.

I hope the overview is useful to both beginning researchers and established scholars in propelling us to develop more pedagogically and cost-effective forms of interacting with each other and with our environment.

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