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LEARNING EFFECTIVENESS ONLINE: WHAT THE RESEARCH TELLS US

Karen Swan
Research Center for Educational Technology, Kent State University

ABSTRACT
This paper reviews the literature on the learning effectiveness of asynchronous online environments. It looks beyond the commonly accepted findings of no significant differences in learning outcomes between online and traditional courses to examine that literature in terms of forms of interactivity, a feature of online environments that might matter or be made to matter in learning. It thus explores and is organized according to learner interactions with course content, student interactions with instructors, and interactions among classmates in online course environments. More recent notions of interactions with computer and course interfaces and virtual interaction are also briefly examined. The chapter concludes with a summary of what the research tells us and its for implications online learning.

KEYWORDS
learning effectiveness, asynchronous learning networks, distance education, online learning, interaction with content, teaching presence, social presence, virtual communities, interface, virtual interaction

INTRODUCTION

> "LEARNING EFFECTIVENESS means that learners who complete an online program receive educations that represent the distinctive quality of the institution. The goal is that online learning is at least equivalent to learning through the institution's other delivery modes, in particular through its traditional face-to-face, classroom-based instruction.. . . Interaction is key." [1]

The goal, the raison d'etre, the stuff of education is learning. Thus learning effectiveness must be the first measure by which online education is judged. If we can't learn as well online as we can in traditional classrooms, then online education itself is suspect, and other clearly critical issues, such as access, student and faculty satisfaction, and (dare we say it) cost effectiveness are largely irrelevant. Indeed, when online learning was first conceived and implemented, a majority of educators believed that it could never be as good as face-to-face learning. Many still do. In fact, however, we now have good and ample evidence that students generally learn as much online as they do in traditional classroom environments.

"No Significant Difference"

For example, Johnson, Aragon, Shaik and Plama-Rivas [2] compared the performance of students enrolled in an online graduate course with that of students taking the same course taught in a traditional classroom. Using a blind review process to judge the quality of major course projects, they found no significant differences between the two courses. The researchers further found that the distributions of course grades in the two courses were statistically equivalent. Maki, Maki, Patterson and Whittaker [3],

in a two-year quasi-experimental study of undergraduate students, found more learning as measured by content questions and better performance on examinations among students in the online sections of an introductory psychology course.

Fallah and Ubell [4] compared midterm exam scores between online and traditional students at Stevens Institute of Technology and found little or no difference in student outcomes. Freeman and Capper [5] found no differences in learning outcomes between business students participating in role simulations either face-to-face or asynchronously over distance. Similarly, Ben Arbaugh [6] compared the course grades of classroom-based and Internet-based MBA students and found no significant differences between them. In a study of community health nursing students, Blackley and Curran-Smith [7] not only found that distant students were able to meet their course objectives as well as resident students, but that the distant students performed equivalently in the field. Similarly, Nesler and Lettus [8] report higher ratings on clinical competence among nurses graduating from an online program than nurses who were traditionally prepared.

Several researchers have used faculty perceptions of student learning as a measure of learning effectiveness in online courses. Dobrin [9], for example, found that 85% of the faculty teaching online courses felt that student learning outcomes were comparable to or better than those found in face-to-face classrooms. Hoffman [10] reports similar findings, as does Hiltz [11]. in this vein, other researchers have surveyed students and used their perceptions of their own learning as an effectiveness measure. Shea, Fredericksen, Pickett, Pelz and Swan [12], for example, found the 41% of 1,400 students enrolled in SUNY Learning Network's online classes believed that they learned as much as they learned in traditional classes. Forty-seven percent thought they learned more. Many researchers [13, 14, 15] have reported similar findings.

Indeed, Thomas L. Russell [16] created a “No Significant Differnce” website that presents the results of 355 research reports, summaries and papers reporting no significant differences between the learning outcomes of students learning over distance and students learning in traditional classrooms. Likewise, in a review of distance education studies involving students in the military, Barry and Runyan [17] found no significant learning differences between resident and distant groups in any of the research they reviewed. Most recently, Hiltz, Zhang and Turoff [18] reviewed nineteen empirical studies comparing the learning effectiveness of asynchronous online courses with that of equivalent face-to-face courses. Using objective measures of content learning as well as survey responses by faculty and students, the studies provide “overwhelming evidence that ALN tends to be as effective or more effective than traditional course delivery.”

Of course, there have been instances in which studies have reported significantly poorer learning in online courses. For example, Chen, Lehman, and Armstrong [19] compared traditional, correspondence, and online learners and found that achievement test scores were highest for correspondence students and lowest for students taking courses online. Similarly, Brown and Liedholm [20] report significantly worse performance on examinations for virtual graduate microeconomics classes. These sorts of findings, however, are very much in the minority.

Of greater importance are methodological problems in studies comparing learning from online and traditional courses. Methodologies for research on the learning effectiveness of online courses are critically examined by Starr Roxanne Hiltz and J. Ben Arbaugh in their excellent chapter in this volume. Despite many such problems, however, it is clear that when compared using gross measures of learning

effectiveness, students learn as much if not more from online courses as they do in traditional higher education courses.

Beyond "No Significant Difference"

Another potential problem with comparisons of the learning effectiveness of online and traditional education is epistemological and involves the notion of no significant difference itself. The "no significant difference" paradigm stems from an article written by Richard Clark [21] for the *Review of Educational Research* in which he argued that media do not make a difference in learning but rather that instruction does. Clark was particularly concerned with several studies of computer-assisted instruction (CAI) that compared it with traditional instruction and found that students at a variety of levels learned more and faster from CAI [22]. Clark argued that these and other findings of significant differences between technology-based and traditional interventions resulted from more rigorously designed instruction, not from media effects. Media, he maintained, were like trucks, they were delivery vehicles and no more.

What mattered, according to Clark, was the quality of instruction, not how it was delivered. The CAI studied, for example, was rigorously designed according to principles of instructional design, while the traditional instruction with which it was compared was not. Thus, Clark argued that media effects were a chimera because if instruction were held constant there would be no significant learning differences between technology-based and traditional education. Early proponents of distance education picked up on Clark's ideas to support their cause. Well designed instruction, they argued, was well designed instruction, regardless of how it was delivered. Thus, they maintained, as long as the quality of instruction delivered over distance was as good as the quality of traditional education, there would be no significant differences in learning between them. Indeed, as we have seen, the research supports such a view.

Clark's position, however, has been challenged by many in the educational technology community, notably Kozma [23]. Kozma conceded the importance of instructional design, but argued that media mattered too. What makes CAI so effective, for example, is its ability to deliver instruction that is individualized for every student and that provides them with extensive practice and immediate feedback. Of course a human tutor working one-on-one with an individual student could do the same [24], but teachers working in traditional classrooms cannot and the notion of tutors for all students is more than impractical. All media particularly support specific kinds of instruction and are less supportive of others [25]. Indeed, most educational technologists today agree that instruction should be designed to take advantage of the unique characteristics of media that matter or that can be made to matter in teaching and learning.

The epistemological problem with the "no significant difference" concept, then, is that it glosses over real differences in the asynchronous online medium that might be uniquely supportive of particular ways of knowing and learning. Carol Twigg [26] contends that the biggest obstacle to innovation in online learning is thinking things can or should be done in traditional ways. Trying to make online education "as good" as traditional education often encourages us to make it the same as traditional education. Trying to make online education "the same" most likely will lead to less than optimal learning, when, in fact, online education has the potential to support significant paradigm changes in teaching and learning. Twigg focuses on the potential of online environments to support individualized instruction. Randy Garrison, in an excellent contribution to this volume, explores the unique ability of asynchronous online learning to support both reflection and collaboration, and relates these to Dewey's notion of the inquiry cycle. In this chapter, I will discuss what the research tells us about the effectiveness of asynchronous online learning in terms of interactivity.

Online Interactions

Central to the concepts of both learning and computer mediation is the notion of interaction. Interaction refers to reciprocal events involving at least two actors and/or objects and at least two actions in which the actors, objects, and events mutually influence each other [27]. No matter what learning theories we hold -- behaviorist, constructivist, cognitivist, or social -- reciprocal events and mutual response in some form must be integral to our notions of how we learn. Similarly, interaction is widely cited as the defining characteristic of computing media [28, 29, 30, 31, 32]. What computer can do that other media can't is change in response to user input and so interact with them. Computer-based telecommunications connect people beyond the limitations of space and time to promote interactions among people who might not otherwise interact. Because interaction seems to central to multiple conceptualizations of both learning and learning online, and because it highlights what is unique in online learning and hence the potential for paradigm change, I will use it as an organizing characteristic in the review of research and program initiatives which follows.

Researchers concerned with computer-based education have identified three kinds of interactivity that affect learning: interaction with content, interaction with instructors, and interaction among peers [33]. Interaction with content refers both to learners' interactions with the course materials and to their interaction with the concepts and ideas they present. Interaction with instructors includes the myriad ways in which instructors teach, guide, correct, and support their students. Interaction among peers refers to interactions among learners which also can take many forms -- debate, collaboration, discussion, peer review, as well as informal and incidental learning among classmates. Each of these modes of interaction support learning and each can be uniquely enacted in online learning environments.

Of course, none of the three modes of interaction function independently in practice. Interaction among students, for example, is supported by instructor facilitation and support, and, because it centers on content, can be seen as a variety of that type of interaction. Thus, a useful way of thinking about the three forms of interaction is provided by Rourke, Anderson, Garrison & Archer's [34] "community of inquiry" model of online learning. If one equates cognitive presence in this model with interaction with content, teaching presence with interaction with instructors, and social presence with interaction among students, it gives a good representation of how all three work together to support learning online (Figure 1). At the same time it should be remembered that both teachers and students have social presence, that in many online courses, both teachers and students teach, and that learning is always learning of content.

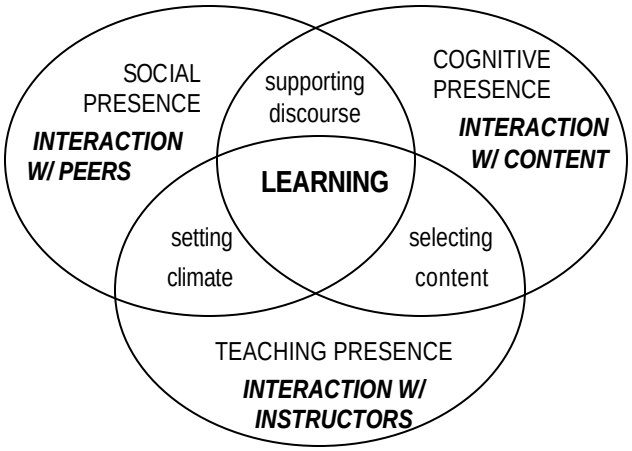

Figure 1: Interactivity and Learning Online
adapted from Rourke, et. al's (2001) community of inquiry model

This paper will explore current research concerned with online learning effectiveness in terms of learners' interactions with course content, with their instructors, and with their classmates, as well as briefly examining two other sorts of interaction suggested in the literature -- interaction with course interfaces and vicarious interaction -- with the hope that such focus will highlight some of the ways in which asynchronous online networks may uniquely support particular kinds of learning. It is important to remember, however, that none of these interactions stand alone and that all of them involve, to greater or lesser degrees, all three sorts of presence identified in the community of inquiry model.

INTERACTION WITH CONTENT

Interaction with content refers to the learners' interaction with the knowledge, skills and attitudes being studied. In general, this has to do with the learners' interaction with the course materials and is so primarily concerned with course design factors, but it plays out, of course, across all the interactions. Measurement of online content learning has been undertaken in terms of performance (course grades, exams, written assignments, etc.) and perceptions of learning by students and faculty. As noted above, most of this research has involved comparisons of learning online with learning in traditional classrooms, and most of that has found no significant differences in learning outcomes between the two modes of learning. More recently, however, innovative studies have looked more specifically at particular cognitive skills [35, 36, 37], and these sorts of studies are hinting at particular affordances and constraints for learning online.

All of us are aware of the enormous amount of content available through the World Wide Web; many of us are overwhelmed by it. Shank [38], however, warns that information is not learning. Indeed, researchers agree that many computer-based educational offerings provide poor learning opportunities [39, 40]. Much of what we do know about design for online learning has been extrapolated from research on learning in general, and computer-based learning and multimedia design in particular. Janick & Liegle [40] have synthesized the work of a range of instructional design experts in these areas [22, 41, 42, 43, 44, 45] to develop a list of ten concepts that support the effective design of web-based instruction. These are:

- Instructors acting as facilitators
- Use of a variety of presentation styles
- Multiple exercises
- Hands-on problems
- Learner control of pacing
- Frequent testing
- Clear feedback
- Consistent layout
- Clear navigation
- Available help screens

Chickering and Gamson's "Seven Principles for Good Practice in Undergraduate Education," updated for online learning, are based on research and practice in traditional undergraduate education [46]. These include:

- Contacts between students and faculty
- Reciprocity and cooperation among students
- Active learning techniques
- Prompt feedback
- An emphasis on time on task
- Communication of high expectations
- Respect for diverse talents and ways of learning

Similarly, Keeton, Scheckley and Griggs [47] have adapted and revised the seven principles according to a survey of twenty years of teaching practices, basing their eight principles on the practices they find to have had the greatest impact on learning gains in higher education:

- Make learning goals and one or more paths to them clear
- Use deliberate practice and provide prompt constructive feedback
- Provide an optimal balance of challenge and support that is tailored to the individual students' readiness and potential
- Broaden the learners' experience of the subject matter
- Elicit active and critical reflection by learners on their growing experience base
- Link inquiries to genuine problems or issues of high interest to the learners to enhance motivation and accelerate their learning
- Develop learners' effectiveness as learners early in their education
- Create an institutional environment that supports and encourages inquiry

We can extrapolate from what we know about computer-based learning and learning in higher education and look for intersections across the two domains. What these sets of organizing concepts seem to have in common, then, is that they suggest online developers and instructors provide:

- Clear goals and expectations for learners,
- Multiple representations of course content,
- Frequent opportunities for active learning,
- Frequent and constructive feedback,
- Flexibility and choice in satisfying course objectives, and
- Instructor guidance and support.

Although anecdotal reports on asynchronous learning networks give a good deal of support for such a framework [26, 48], and it is well accepted that these design principles support computer-based learning and adult learning in general, it remains to be seen whether they apply to online courses in particular. Swan, Shea, Fredericksen, Pickett, Pelz. and Maher's [49] research on course design factors affecting student perceptions of learning, for example, suggests that several design characteristics that typically

affect student perceptions in traditional, face-to-face classes may be irrelevant online. Research testing the particular effects of specific strategies for online design and instruction need to be undertaken in a rigorous manner (See Hiltz & Arbaugh in this volume). Each of the above principles, for example, could be explored using experimental or quasi-experimental methods within the asynchronous online framework to test whether they really matter in such format.

Some research of this kind has been undertaken. For example, early research on asynchronous online learning has shown that the structure [50], transparency [51], and communication potential [52] of course designs heavily impact students' learning. Swan, et al. [49] examined the relationships between course design factors and students' perceived learning in 73 different online courses and found significant correlations between the clarity, consistency, and simplicity of course designs and students' perceived learning. Such findings support the above prescription for clear goals and expectations for learners. They also perhaps suggest both a constraint of asynchronous online environments and a way of ameliorating that constraint. Because real-time negotiation of meaning is impossible among instructors and students separated by space and time, clarity of meaning is more important in online classes. Consistent, transparent, and simple course structures add to such clarity as well as insure that learners only have to adapt to such structures once.

Swan et. al [49] also found significant correlations between perceived student learning and instructor feedback (interaction with instructors), between perceived student learning and communication with peers (interaction among classmates), and between students' perceived activity in courses (interaction with content) and their perceived learning. Others [35] report similar findings. These results support the above prescriptions for frequent opportunities for active learning, frequent and constructive feedback, and instructor guidance and support.

Thus, these findings support, in part, some of the above prescriptions, but not all, and certainly not exhaustively. Specific areas that have not been well explored include the areas of multiple representations of content, student flexibility and choice, and instructors as mentors and guides. Coincidently, these are also areas in which online learning has the potential to significantly affect paradigm change. They thus very much deserve further investigation.

Personalization

As previously noted, one of the unique things that computer supported interactivity allows is the individualization of instruction. Indeed, when Carol Twigg [26] gathered together a group of innovative online faculty and administrators in a Pew sponsored symposium to discuss paradigm changes in online learning, their overall conclusion was that individualization was the key to innovation in distance education. Better quality learning, they agreed, would result from the greater personalization of learning experiences for all students. Symposium participants identified five key features of pacesetting programs that support personalization of learning:

- An initial assessment of each student's knowledge, skills, and preferred learning style
- An array of high-quality, interactive learning materials and activities
- Individualized study plans
- Built-in, continuous assessment to provide instantaneous feedback
- Appropriate, varied kinds of human interaction when needed

The University of Phoenix, for example, welcomes students by name. They access and collect learners' personal information to maintain individualized relationships with them and to personalize feedback on their work in progress [53]. At Penn State, David DiBiase [54] inaugurated "student learning e-portfolios" so students could more actively plan their own educational goals, share examples of their work with potential employers, master transferable information technology skills, demonstrate knowledge gained beyond the classroom, present authentic evidence of learning outcomes, and so personalize their learning experiences.

Many online programs personalize instruction by offering much greater flexibility in terms of time as well as space. Rio Salado College's online program, for example, uses a computer-based management system to make ninety percent of its courses available for students to enroll in every two weeks [55]. Similarly, Cardean University permits students in all their online MBA courses to start any time and to progress at their own rate [56]. Excelsior College [57] does not even require academic residency. Rather, Excelsior recognizes student learning from any source by offering standardized credit-by-examination college programs that validate learning through standardized assessment which is recorded as college transcripts.

Other institutions have used online formats to let students personalize their learning experiences themselves. For example, Ed Kashy and Michael Thoennessen [58] at Michigan State University helped design CAPA, a quizzer, randomizer, grader, and manager that helps students identify their own errors and correct individualized problems. Students in Ohio State University's introductory statistics courses can choose a variety of formats – lectures, video examples, individual or group discovery laboratories, remedial/perquisite training modules, graded homework assignments, , individual or group review, individual or group projects – to meet specific course objectives [59]. Stanford University has created "courselets," self-contained, integrated tutorials covering a small set of concepts to be used across science and engineering courses [60]. Courselets can be accessed by students who need particular knowledge and/or skills as pre-requisites for other learning, want to extend their knowledge in a particular area, and/or are interested in cross-curricular applications of concepts.

At Virginia Polytechnic Institute, linear algebra students are given flexibility in both time and learning experiences to meet course objectives [61]. Students can choose either traditional instruction or utilize the totally asynchronous online Math Emporium that allows them to work their way through content units. In the Math Emporium students choose when to access course materials, what types of materials to use, and how quickly to work through the units. Learning is assessed through short, electronically graded quizzes associated with each unit. Final exam scores, general education outcomes, and longitudinal follow-up studies all indicate that the achievement of online students is consistent with that of students, both at Virginia Polytechnic Institute and elsewhere, learning linear algebra in traditional ways.

While most of these innovative programs and others like them report no significant differences in learning outcomes when compared with traditional instruction, they neither discuss nor explore what specific kinds of learning personalization might support, let alone investigate why they might better support them. For example, studies of student learning from computer-assisted instruction (CAI) suggest that CAI may better support the learning of discrete facts and concrete skills than more complex and integrated kinds of understanding [62]. Research on student choice of learning formats has been very mixed in finding any benefit from such option; indeed the negative results of learner control have been widely reported [63, 42]. Thus, rigorous and specific investigations of the particular benefits, and potential deficits, of personalization in online environments are very much called for.

Another issue surrounding personalization, especially individualization in terms of temporal flexibility, is the trade off between individualization and social learning. As noted previously and as illustrated in the community of inquiry model (Figure 1), interactions with content overlap with interactions with instructors and peers. Extreme individualization cuts students off from these human interactions, most especially from interactions with classmates. Most contemporary theories of learning maintain that learning is, at least in part, social in nature, and that knowledge is constructed through social interactions among people [64]. It may also be that students enjoy learning with others (See the section on Student Satisfaction in this volume). Thus, future research should examine personalization and learning in relationship to social interactions and student satisfaction.

Multiple Representations

In this vein, many researchers note that students perceive online learning as more equitable and more democratic than traditional classroom learning [65, 66] because it allows for the presentation and inclusion of multiple points of view. Such a view suggests that online environments may be particularly supportive of what Judith Langer terms "literary understanding" [67], the divergent consideration of a variety of possibilities and perspectives. Similarly, Rand Spiro's [68] cognitive flexibility theory suggests that hypermedia (of which the World Wide Web is the extreme example) can uniquely support learning environments that allow for multiple representations of complex material. Spiro's research on learning from hypermedia found that students who explored complex topics from multiple perspectives through hypermedia programs scored higher on measures of complex understanding then students presented with similar material through a traditional (linear) CAI format. Thus, online environments might be particularly supportive of the development of literary understanding, divergent thinking, and/or complex conceptual knowledge.

Indeed, some researchers have begun exploring learning specific kinds of content that may support such contention. Drew Parker and Andrew Gemino [41] at Simon Fraser University, for example, compared student learning of both concepts and techniques between traditional and online versions of a course in systems analysis and design for business majors. Although there were no significant differences in final exam scores between classes, on closer examination they found that students in the traditional classes scored significantly higher on the technical part of the exam, while students in the online sections scored significantly higher on the conceptual part of it. Benbunan-Fich and Hiltz [69] found that both individuals and groups working on ethical case scenarios with ALN support produced greater quantity and better quality solutions than either individuals or groups working without such support. Further research into online support for the development of particular kinds of knowledge, skills, and understandings, in particular for learning complex concepts or exploring multiple viewpoints,, is clearly indicated.

Indeed, Picciano [37] reports a congruent finding from his study of an online graduate course in educational administration that relates directly to interaction. He found that students classified as highly interactive scored significantly better on a written assignment (an analysis of a particular case study) than students classified as either moderately or less interactive in the course. Picciano attributes the higher written assignment scores of the more interactive students to their greater ability to integrate multiple perspectives in deciding whether and how to implement an academic program, an ability he suggests they may have developed through their extensive interaction with other students' points of view in the course discussions. No corresponding differences were found between these high medium and low groupings on exam scores. Picciano suggests that the kinds of learning assessed by the multiple choice exams might be done as well individually as through group interaction. Picciano's research suggests interesting directions for future exploration of the potential benefits of both multiple representations and individualization, as

well as the possibility of personalization of online experiences relative to particular learning styles. All these areas clearly deserve further investigation.

INTERACTION WITH INSTRUCTORS

A second type of interaction in online environments occurs between learners and their instructors. In any educational setting, the instructor serves as an expert who plans instruction to stimulate students' interests, motivates their participation in the learning process, and facilitates their learning. The relationship between instructor/student interactions and learning outcomes has been well documented in traditional classrooms [70, 71]. It stands to reason that interactions with instructors would be equally important online.

Research on learning through interactions with instructors, however, has yet to clearly document relationships between online teaching behaviors and student learning. Research to date is preliminary but intriguing. It has mostly been correlational and based on interview and survey data and faculty and student perceptions, but these do hint at important relationships between instructor activity and student learning. Initial investigations of instructor roles in online environments also seem quite promising. Nonetheless, much work still needs to be done in this area.

As noted, what research there is linking interactions with instructors and student learning is based, for the most part, on perceptions of the same. Richardson and Ting [71], for example compared the perceptions of two groups of students involved in asynchronous learning. They found that students learning through written correspondence with instructors were more concerned with instructor feedback than any other sort of interaction with their instructors, whereas students learning online felt that all interactions with instructors mattered. Shea, et al [72] found significant differences in perceived learning among students interacting with their instructors at differing perceived levels. Students who reported low levels of interaction with their instructors also reported the lowest levels of learning. Conversely, students who reported high levels of interaction with their instructors also reported higher levels of learning from them. Swan, et al. [49] found a strong correlation between student perceptions of learning and their perceived interactions with instructors. Richardson and Swan [73] similarly reported a significant correlation between student satisfaction with their instructors and their perceived learning online, and Jiang and Ting [74] found correlations between perceived interactions with instructors and perceived learning.

A few quantitative studies have gone beyond perceptions to examine actual instructor activity in online classes. Jiang and Ting [74], for example further reported that both perceived learning and perceived interaction with instructors were linked to the actual average numbers of responses per student that instructors made. Swan, et al. [49] also found a weak correlation between students' perceived interaction with their instructors and the actual frequency of instructor interaction in online course discussions. Picciano [14] likewise found that instructors' activity was related to students' perceived learning in an online graduate level course in educational administration. These findings indicate the importance to students of interactions with their instructors in online environments. Connections between student interactions with their instructors and learning outcomes have yet to be documented, however. Also of interest are the ways in which instructors facilitate interaction among classmates in online course discussions and how these relate to learning therein. All are promising areas for further investigation.

Teacher Immediacy / Teaching Presence

One aspect of particular importance in understanding the efficacy of teacher/student interactions in face-to-face classrooms is the notion of teacher immediacy and immediacy behaviors. "Immediacy" refers to the "psychological distance between communicators" [75]. Educational researchers have found that both teachers' verbal immediacy behaviors (ie., giving praise, soliciting viewpoints, humor, self-disclosure) and their non-verbal immediacy behaviors (ie., physical proximity, touch, eye-contact, facial expressions, gestures) can lessen the psychological distance between teachers and their students, leading (directly or indirectly, depending on the study) to greater learning.

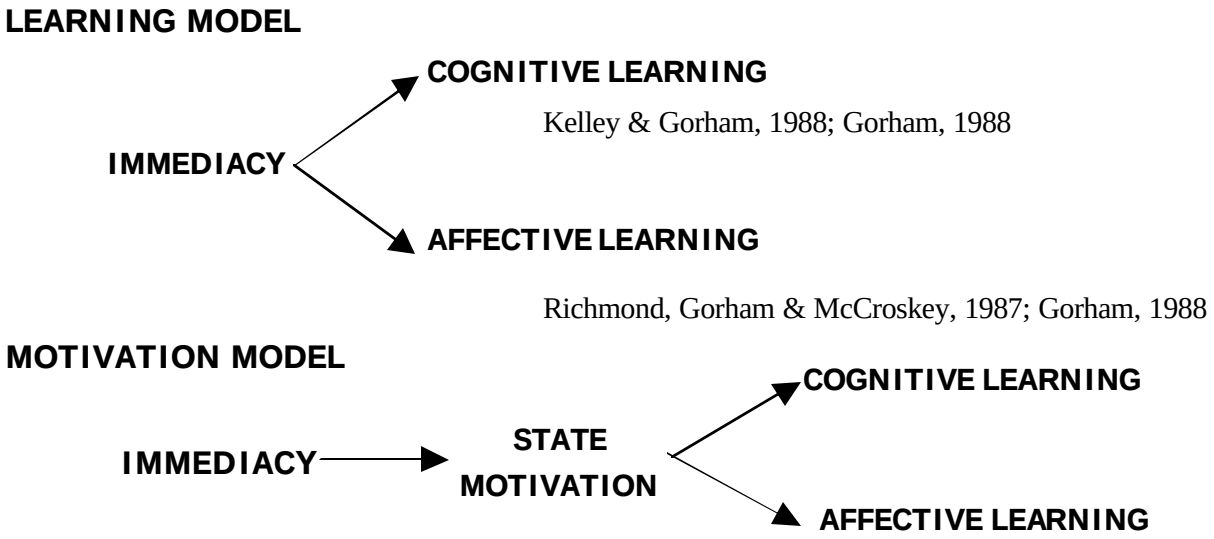

Figure 2: Research-Based Models of the Relationship Between Immediacy Behaviors and Learning

For example, while early research on immediacy posited a direct relationship (learning model) between teachers' immediacy behaviors and both cognitive [76, 77] and affective learning [77, 78, 79], more recent immediacy research has come to believe that intervening variables mediate the relationship. In motivation models [80, 81, 82], the intervening variable is hypothesized to be state motivation. In these kinds of models, teachers' immediacy behaviors are conceptualized as increasing students' motivation to learn resulting in greater affective and cognitive learning. In Rodriguez, Plax and Kearney's [83] affective learning model, affective learning itself is seen as the intervening variable; that is, teacher immediacy behaviors are seen as increasing students' affective learning which in turn affects their cognitive learning. Figure 2 graphically represents these proposed models.

Whatever the proposed model of the relationship between teacher immediacy behaviors and learning, a positive relationship between teacher immediacy and learning has been clearly documented in the research literature. This has led certain theorists to suggest that asynchronous media, because they are less personal than media which transmit non-verbal and/or vocal communications, are less capable of representing teacher immediacy, in this literature referred to as "social presence" [84, 85, 86], hence, by implication, are less capable of supporting learning. Researchers and practitioners experienced with online teaching and learning, however, contest this view. They argue that rather than impersonal, computer-mediated communication often seems “hyper-personal” [87], that participants in computer-mediated communications create social presence by projecting their identities through verbal immediacy behaviors alone [34, 74, 88, 89, 90].

This latter research, however, centers on online course discussions, hence on interactions among discussion participants, of which interactions between instructors and students are only a small, usually unidentified, fraction. As previously noted, research focusing on the roles instructors play in online discussions and their relationship to knowledge creation and learning within them is definitely a priority. Also of interest are other sorts of interactions between online instructors and students such as instructor feedback on assignments, journaling between instructors and students, and teaching presence in online lectures.

In this vein, several researchers have attempted to categorize the roles online instructors perform to reflect the ways in which they project their presence. Berge [91], for example, maintains that moderators of online discussions must fulfill four major functions -- managerial, social, pedagogical and technical. Paulson [92] reduces these to three sets of functions -- organizational, social, and intellectual. Rossman [93 provides empirical support for similar categories through the analysis of over three thousand student course evaluations. He found that student comments and complaints concerning their online instructors clustered into three major categories -- teacher responsibility, facilitating discussions, and course requirements.

Anderson, Rourke, Garrison and Archer [94] have termed instructors' ability to project themselves in online courses "teaching presence," which they define as "the design, facilitation and direction of cognitive and social processes for the purpose of realizing [students'] personally meaningful and educationally worthwhile outcomes." They conceive of teaching presence as composed of three categories of activities roughly analogous to those defined by Berge, Paulson and Rossman -- design and organization, facilitating discourse, and direct instruction -- and have created protocols to measure teaching presence in terms of these categories through the content analysis of thematic units in online discussions. The protocols have been tested in the analysis of the complete transcripts of two online courses and proved both reasonably reliable and useful in identifying differences in both the quantity and quality of the teaching presence projected by differing online instructors. How such differences might relate to learning have not yet been hypothesized, let alone investigated, but Anderson et al.’s protocols provide a good beginning.

In a similar vein, Coppola, Hiltz, and Rotter [95] investigated the changing roles of instructors teaching online classes through semi-structured interviews with twenty faculty members who had prepared and delivered at least one online course. They assert that, in the any environment, teachers have three roles – cognitive, affective, and managerial. They found that the instructors they interviewed believed that in online environments their cognitive role shifted to one of deeper complexity, their affective role required finding new tools to express emotion, and their managerial role necessitated greater attention to detail, more structure, and additional student monitoring. Anderson, Rourke, Garrison, and Archer [94] report similar shifts in responsibilities.

For example, at the University at Albany, Donna Rogers [96] responds privately to all her students' discussion postings in online course on educational computing and media in teaching and learning. Rogers believes this practice allows her to interact with her students around issues of content without depressing the range and variety of viewpoints expressed in the public discussion. At the University of Northern Virginia [97], students can elect to take courses in tutorial mode, an electronic extension of the time-honored tradition of mentoring. In tutorial mode classes, students interact in a similar one-on-one manner with their instructors around course assignments. All other interactions are voluntary. Murray Turoff [98] at the New Jersey Institute of Technology believes that a key instructor role is to motivate, encourage and facilitate authentic, active and collaborative interactions among students. He has developed a carefully focused structure for his course in interface design and management of information systems that breaks course activities into small manageable parts associated with discussions of related topics and large course discussions into smaller collaborative groups. This careful structuring, Turoff contends, allows him to teach large enrollment classes in an intimate and interactive way.

Many institutions offering online courses recognize both the importance of interaction with instructors online and changing faculty roles therein. They thus offer extensive trainings for their faculty that go beyond technical training to address issues of online pedagogy at the University of Central Florida [99] Penn State [100], Stevens Institute [101], and the SUNY Learning Network [102], to name just a few. Many institutions also offer online pedagogical support for faculty. For example, the University of Maryland [103] offers nine online training modules at a variety of levels as well as current listings for training opportunities for faculty across the state. Similarly, the University of Washington has created a web-based resource for its online faculty that offers practical advice on design and teaching an online course [104]. The University of Illinois at Springfield provides their faculty with a daily review of news, research, and information on asynchronous online learning with links to complete reports [105].

INTERACTION WITH CLASSMATES

Socio-cognitive theories of learning maintain that all learning is social in nature and that knowledge is constructed through social interactions [65]. Online education seems particularly well constructed to support such social learning because of the unique nature of asynchronous course discussions [106]. To begin with, all students have a voice and no student can dominate the conversation. The asynchronous nature of the discussion makes it impossible for even an instructor to control. Whereas discussion in traditional classrooms is, for the most part, transacted through and mediated by the instructor, online discussion evolves among participants. Accordingly, many researchers have found that students perceive online discussion as more equitable and more democratic than traditional classroom discourse [66, 67]. In addition, because it is asynchronous, online discussion affords participants the opportunity to reflect on their classmates' contributions while creating their own, and on their own writing before posting it. This tends to create a certain mindfulness and a culture of reflection in online courses [107, 108].

However, as Eastmond [51] reminds us, computer-mediated communication is not inherently interactive, but depends on the frequency, timeliness, and nature of the messages posted. Ruberg, Moore and Taylor [109] found that computer-mediated communication encouraged experimentation, sharing of ideas, increased and more distributed participation, and collaborative thinking, but also found that for online discussion to be successful, it required a social environment that encouraged peer interaction facilitated by instructor structuring and support. Hawisher and Pemberton [110] relate the success of the online courses they reviewed to the value instructors placed on discussion. Students in these courses were

required to participate twice weekly and 15% of their grades were based on their contributions. Picciano [14] likewise found that students' perceived learning from online courses was related to the amount of discussion actually taking place in them. Likewise, Jiang and Ting [75] report correlations between perceived learning in online courses and the percent of course grades based on discussion, and between perceived learning and the specificity of instructors' discussion instructions.

Similarly, Shea, Swan, Fredericksen and Pickett.'s [111] study of 268 online courses across the State University of New York system found significant differences in students' perceived learning among differing levels of perceived peer interaction. Students who rated their level of interaction with classmates as high also reported significantly higher levels of learning. Swan et. al. [49], moreover, found a strong correlation between students' perceptions of their interactions with peers and the actual frequency of interactions among students. They also found correlations between students' perceived interaction with peers and the percentage of course grades based on discussion, the required frequency of student participation in discussions, and the average length of discussion responses.

In their 1996 commentary on the ways technology influences practices, Chickering and Ehrmann [46] noted that "the biggest success in this realm has been that of time-delayed (asynchronous) communication . . . [in which] total communication increases and, for many students, the result seems more intimate, protected, and convenient than the more intimidating demands of face-to-face communication with faculty." Interactions among students through asynchronous discussion have thus been perceived by many to be one of the most unique, and so interesting, sources of learning in online courses [49, 112, 113]. They are also perhaps the best researched to date. Much of that research has been premised on research on the social aspects of learning in face-to-face environments. Because interactions among classmates are arguably significantly different in online environments, research in this area needs, as Picciano [14] argues, to begin relating social concepts to actual learning and actual interactions.

"Social Presence"

As previously noted, "immediacy" refers to perceived "psychological distance between communicators" [76]. In traditional, face-to-face classrooms, educational researchers have found that teachers' immediacy behaviors can lessen the psychological distance between themselves and their students, leading, directly or indirectly depending on the study, to greater learning [76, 77, 78, 79, 80, 81, 82, 83, 114, 115].

That the immediacy research in traditional classrooms has implications for learning through online communications has also been previously noted. Some communication researchers argue that differing media have differing capacities to transmit the non-verbal and vocal cues that produce feelings of immediacy in face-to-face communication. Short, Williams & Christie [83] refer to these capacities as "social presence," or the "quality of a medium to project the salience of others in interpersonal communication." They contend that low bandwidth media, such as text-based computer-mediated communication, have less social presence, and by extension promote less learning, than media with greater communication potential. Media richness theory [84] reaches a similar conclusion, as does Picard's [85] more recent notion of "affective channel capacity".

Researchers experienced with online teaching and learning, however, contest this view. Participants in computer-media communications, they argue, create social presence by projecting their identities into their communications. Walther [87], for example, argued that participants in strictly text-based electronic conferences adapt their language to make missing non-verbal and vocal cues explicit and so develop

relationships that are marked by affective exchanges. What is important, these researchers contend, is not media capabilities, but rather personal perceptions of presence [34, 74, 88, 108, 115].

Of course, as also previously noted, online discussions are qualitatively different from discussions in face-to-face classrooms. In particular, the role of instructors shifts from discussion leader to discussion facilitator, and students commonly assume more responsibility [94, 95, 108, 116]. Research on immediacy in face-to-face classrooms has focused on teacher immediacy behaviors. Research on social presence/immediacy in online environments, however, has accordingly concerned itself with the immediacy behaviors of all discussion participants. In practice, such research has centered on interactions among classmates.

Loni Gunawardena [88, 117], for example, developed a survey to explore student perceptions of social presence in computer-mediated conferences. In two separate studies, she found that students rated the asynchronous discussion as highly interactive and social. Gunawardena concluded that course participants created social presence by projecting their identities to build a virtual discourse community among themselves. Richardson & Swan [74] similarly explored perceptions of social presence among students enrolled in seventeen online courses using a survey adapted from Gunawardena. They found that students' perceived learning, satisfaction with instructors, and perceptions of social presence were all highly correlated. In addition, direct entry regression revealed that students' overall perception of social presence was a strong predictor of their perceived learning in the courses.

To account for such findings, Danchak, Walther, and Swan [118] proposed an equilibrium model of the development of social presence in mediated educational environments (Figure 3). Equilibrium, in this sense, refers to an expected level of interaction in communications [119]. When communicative equilibrium is disrupted (as, for example, when one conversation partner moves doser to another), reciprocal actions to restore equilibrium usually result (as when the other partner moves backward or reduces his gaze). Danchak, et al. suggest that analogous behaviors preserve the expected (from face-to-face-experience) social presence equilibrium in computer mediated communications. They argue that when fewer affective communication channels are available to transmit immediacy via conventional vocal and non-verbal cues, participants in mediated communications will increase their verbal immediacy behaviors to the extent needed to preserve a sense of presence.

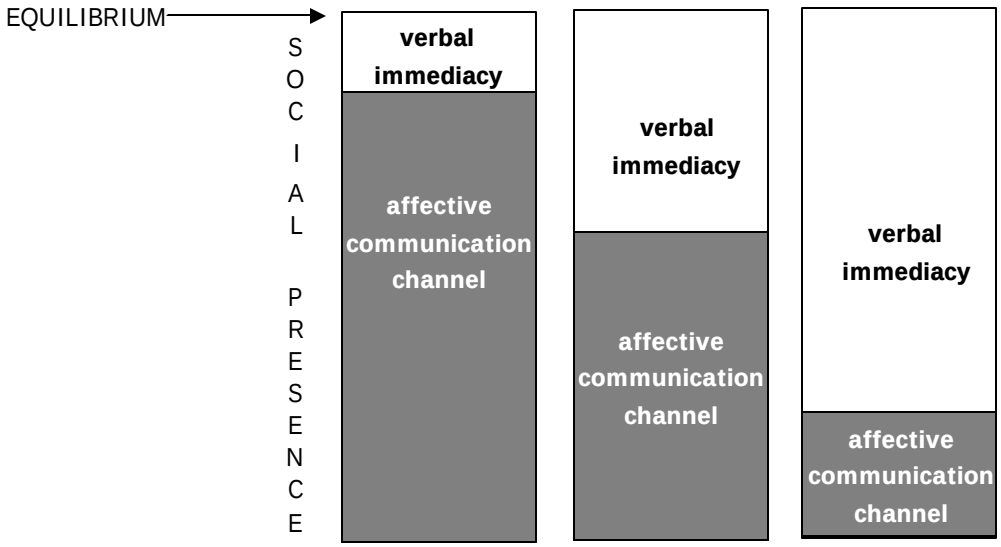

Figure 3: Equilibrium Model of Social Presence

Figure 3 illustrates this equilibrium model. The model suggests that as the capacity of particular media (the vertical bars) to transmit affective immediacy cues (the dark sections of the bars) decreases, people using such media to communicate increase their verbal immediacy behaviors (the white sections of the bars) and equilibrium is maintained.

To further explore the function of verbal immediacy behaviors in the development of social presence in online discussions, Rourke, Anderson, Garrison and Archer [34] distinguished among three kinds of immediacy responses. These are: affective responses (personal expressions of emotion, feelings, beliefs, and values), cohesive responses (behaviors that build and sustain a sense of group commitment), and interactive responses (behaviors that provide evidence that the other is attending). They tested these categories in a pilot content analysis of online discussion and found them quite reliable.

Swan, Polhemus, Shih and Rogers [120] used the categories devised by Rourke, et. al. [34] to develop protocols for the content analysis of online discussion. Swan [115] applied these to the analysis of discussions in a graduate education course. She found an average of six verbal immediacy indicators per discussion, lending support to the equilibrium model. In addition, the analyses revealed that, although the use of affective indicators mirrored the general flow of the course discussions as the course progressed across time, cohesive indicators declined in frequency, while the frequency of interactive indicators increased. These findings suggest that different kinds of immediacy indicators perform different functions in the development and maintenance of social presence and that the importance of these functions varies across time and context.

Most studies of social presence in online discourse are premised on the assumption that social presence enhances learning. Such premise, of course, derives from research on immediacy in face-to-face classrooms. As we have seen, however, online discussion is significantly different from traditional classroom discussion. In addition, the immediacy research in traditional classrooms has focused exclusively on teacher behaviors, whereas the social presence research in online courses examines the behaviors of all discussion participants. Thus a relationship between social presence and learning through online discussion has yet to be empirically identified and defined.

An important and interesting step in this direction was undertaken by Picciano [37] who related student perceptions of social presence to actual and perceived interactions and learning in an online, graduate level course in education. Picciano analyzed the relationships among survey data on students' perceived social presence, learning, and interaction and measures of their actual interactions in course discussions and performance scores on exams and a written assignment. He found that perceptions of social presence were correlated with perceptions of learning and interaction, and that perceived learning and perceived interactions were also correlated, but that perceived social presence was correlated with neither actual interactions nor performance. He did find, however, that, when learners were split by their interactivity into high, moderate, and low groupings, students in the highly interactive group significantly outperformed the others on the written assignment. When students were similarly grouped by perceptions of social presence, students experiencing the highest levels of social presence also scored significantly higher than the other students on the written assignment. There were no such differences in exam scores. As previously noted, Picciano relates these findings to the potential for interactions in online discussion to support complex understanding, divergent thinking, and the development of multiple perspectives. Such findings clearly deserve further investigation, as does the whole area of the relationship between social presence and learning in online courses. A critical element in that relationship may be instructor behaviors, another factor deserving of future research.

In any case, support for interactions among students and the development of social presence is a priority for many online programs. At Stevens Institute, for example, faculty are specifically encouraged to model verbal immediacy behaviors in course discussions [101]. Similarly, faculty development in the SUNY Learning Network emphasizes socio-cognitive theories of learning and pedagogies designed to support the development of social presence and learning communities [121]. At the University of Phoenix, students are organized into learning teams to provide support and help for one another [53]. Students at the New Jersey Institute of Technology are similarly organized into collaborative groups in which they are encouraged to share their knowledge and experience as well as their learning [98]. At NJIT, students are required to participate in asynchronous discussions and are graded not on the number or size of their contributions but on their quality and timeliness. Similarly, Mercy College's distance learning program has institutionalized a set of criteria for evaluating the quality of discussion postings [122]. According to these criteria, good postings are substantial, concise, provocative, hermeneutical, timely, logical, and grammatical. Only postings that meet these criteria are given full participation credit.

Virtual Learning Communities

The concept of social presence leads to that of virtual learning communities [123, 124, 125, 126, 127, 128, 129]. Virtual learning communities have been variously defined by differing authors, and variations on the term, such as "virtual classrooms" [107], "computer-supported knowledge-building communities" [130], or "communities of inquiry" [34] confuse the issue even further. Most conceptualizations, however, seem to center on one of two foci relating to research on learning communities in general.

Some researchers focus on learning, more specifically, they focus on Scardemalia and Bereiter's [130] notion of learning as collaborative knowledge building. Beverly Hunter [131], for example, asserts that a defining characteristic of a virtual learning community is that "a person or institution must be a contributor to the evolving knowledge base of the group . . . that there is a mutual knowledge-building process taking place". Hoadley & Pea [128] likewise are concerned with knowledge construction. Such definitions are commonly operationalized in terms of evidence of knowledge construction and/or support for knowledge building processes. Other researchers base their work on Lave and Wenger's ground-breaking research on learning communities and on the social relationships that support them [132, 133]. Caroline Haythornthwaite [127], for example, contends that the best way to understand virtual learning communities is to focus on the underlying social networks developing within them. Haythornthwiate suggests studying online learning communities by mapping the social and task support relationships within them.

Some recent, promising notions of virtual learning communities combine the concept of learning with that of community. Nolan and Weiss [129], for example, locate virtual learning communities at "the intersection of the social organization of an environment and the activities expected and conducted by participants in a particular setting. Likewise, Renninger and Shumar [134] view virtual learning communities as lodged in the particular interactions of participants within them. Indeed, it seems that the dual notions of learning and community both rest on and return us to the notion of interaction.

Interaction is one of four components used by Alfred Rovai [135] to define and learning communities, both virtual and traditional. The remaining components include spirit (the recognition of community membership), trust, and learning. Rovai designed a survey instrument, the Sense of Classroom Community Index (SCCI) to measure participants' sense of each of these elements, such that comparisons between learning communities could be made both in terms of overall sense of community and/or on each of the subscales. Using the SCCI, he compared classroom communities among adult learners enrolled in a mix of fourteen traditional and asynchronous undergraduate and graduate courses at two urban

universities. While Rovai found no differences in overall sense of community between the two media formats, he found greater variability in overall SCCI scores among the online courses. Indeed, the five (of seven) online courses with the highest SCCI scores had significantly higher sense of community ratings than did the seven traditional courses. Rovai suggests that this indicates that the development of community in online courses is more sensitive to course design and pedagogical factors than its development is in traditional environments. In this vein, he also found a moderate positive correlation between classroom community ratings and interactivity (as measured by the number of discussion postings) in the online courses.

In addition, Rovai [135]discovered significant differences in conceptual community structure, as indicated by items on the subscales, between the online and face-to-face classes he studied. Specifically, discriminate analyses revealed significant differences in scores on individual survey items indicating that student perceptions of learning and trust were higher in the online classes, whereas student perceptions of community membership was higher in the traditional classes. Rovai suggests that these findings indicate that online instructors should particularly work to promote feelings of community among online students while supporting and building on their perceptions of learning and trust.

Indeed, many online programs specifically support activities aimed at the development of feelings of community. Faculty in the SUNY Learning Network, for example are encouraged to foster a sense of learning community in their courses through such activities as ice-breaker discussions and monitoring of individual students' class participation [102]. The Penn State World Campus wants its online students to identify with Penn State and with each other as members of a community. The World Campus website thus provides them with activities and services specifically designed to encourage that identification, such as news about people in the World Campus community, online student groups, career and leadership opportunities, and other co-curricular learning experiences comparable to that available to resident students [136]. The University of Illinois, Champagne-Urbana's LEEP3 online masters degree program in library and information science uses face-to-face meetings to build community among cohorts and classes of students [137]. Student cohorts begin their program with a twelve-day stay on campus dedicated to developing community while acclimating them to the technology they will use online. All subsequent courses student take include one on-campus session. LEEP3 administrators attribute the program's greater than ninety-five percent retention rate to its attention to community building.

OTHER INTERACTIONS

There is a large body of research on learner interactions with course content, with their instructors, and with other learners in traditional educational settings, and, as we have seen, a growing body of research on student-content, student-teacher, and student-student interactions in online learning environments. Two other sorts of learner interactions that have recently garnered the interest of the distance education community also deserve mention. These are learner-interface interactions and vicarious interactions.

Learner-Interface Interaction

In reviewing the concept of learner interactions as they pertained to distance education, Hillman, Willis, and Gunawardena [138] noted that new and emergent technologies had, at least temporarily, created a fourth type of interaction, learner-interface interaction, which they defined as the interaction that takes place between a student and the technology used to implement a particular distance education process.

Interface in this sense thus refers to specific technologies, platforms, and applications students must use to interact with course content, instructors and classmates online and in other distance learning situations, as illustrated in Figure 4. Interactions with an interface thus afford or constrain [139] the quality and quantity of the other three interactions.

Hillman et al [138] maintained that user-interface interaction involved more than just the mediation that occurs between senders and receivers in all communication, but rather entailed genuine and ongoing interactive processes through which users developed mental models of the interface based on their interpretations of its structure and actions. They further contended that learner-interface interactions were critical because failure to interact successfully could dramatically inhibit learning. For example, a student who has difficulty navigating folders or asynchronous conferences may completely miss vital course content or instructions. At the very least, students who must devote significant mental resources to interface interaction will have fewer resources to devote to learning. On the other hand, productive interactions with well-designed interfaces can enhance learning by elucidating knowledge structures or scaffolding knowledge creation. Thus, Hillman, et al. argued both for well-designed course interfaces and prerequisite orientations to their use.

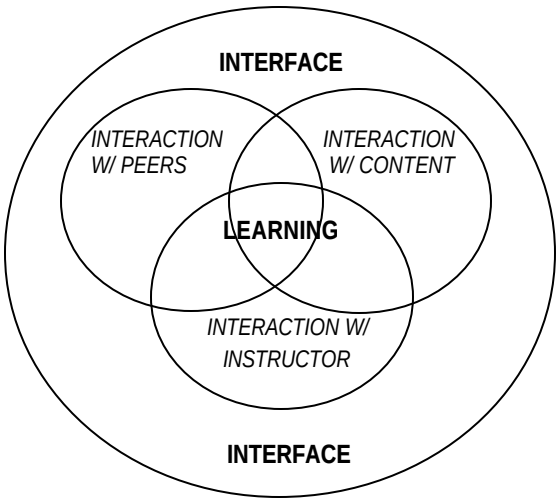

Figure 4: Interaction with Interface Conceptualized

Many online programs have responded to these suggestions. For example, students at Washington State University can access online course information, including syllabi, topics to be covered, resources to be used, and tips for success in online learning, as well as short video introductions to the professor and the course, before enrolling in them. This allows students to become comfortable with the interface (or to reject it) before they commit to its use [140]. Mercy College employs students who are comfortable both with learning online and with Mercy's Merlin system interface to serve as course "wizards". Wizards tutor student newcomers in the use of course interfaces, trouble-shoot and problems they might be having,

and support student learning across time. Wizards also help instructors with course design, contributing a unique and important perspective on interface design in particular [141]. At the University of Illinois Virtual Campus (IVC), students are welcomed to online learning through a carefully designed set of online resources including a tutorials on the use of technology tools, a "Getting Started" guided orientation to the IVC interface, help with academic success skills, career and life planning, and extensive additional resources specifically geared for online and/or distant students. In addition, forty IVC student support centers across the state provide local face-to-face, phone, and/or email support for online students who desire personal contact. [142]. These are just a few examples of student orientation and support systems associated with most online education programs. The ubiquity of these services indicates the necessity for helping students develop effective mental models of course interfaces and so offers pragmatic evidence to support Hillman, et. al.'s notion of interaction with them

There is likewise some empirical support for the notion of learner-interface interaction. Swan, Bowman, Vargas, Schweig and Holmes [143], for example, developed a user response model of the ways in which people make sense of electronic texts from rich observations of students searching for information on the Internet. User response models view meaning as jointly residing in the "reader" and the electronic "text". The authors' "reading the Internet" model also identifies the social, physical, and cognitive contexts surrounding this interaction as contributors to the meaning making process. Their grounded research found that unlike printed texts which most readers singly, users engage electronic texts at three levels, each of which affect meaning making -- the content or page level, the design or website level, and the interface level. Together the design and the interface levels identified in this model involve what Hillman, et al. [138] consider interactions with interface, and observations of user reactions at these levels support their contentions. The researchers found that students not only needed to navigate and make sense of each of these levels before they could process content, but how they interacted with platforms/browsers and the structure of particular websites affected the meanings they eventually developed from that content.

Such findings raise interesting questions and suggest directions for research concerned with learner-interface interactions and their effects on learning. How, for example, might course delivery platforms affect the quality of learning? Most commonly used delivery platforms, for instance, separate course activities by function. Discussion is separate from course documents are separate from written assignments are separate from exams. It could be argued that such structure neither supports knowledge integration nor multiple representations of ideas, but rather constrains them. Investigations into whether this is, in fact, the case, and if, so how that affects learning would be both interesting and informative. Another interesting and potentially rich area for investigation involves the linking of concepts within and beyond online courses. Many scholars [28, 29] believe that linking by association is the most unique and promising attribute of computer-based environments because it allows us to develop ideas in ways that mirror but extend the ways in which we think [144]. We have some evidence that student use of extensively linked hypermedia develops their abilities to make connections between ideas and think in more complex ways [69, 145], but we have not explored the effects of linking in online courses.

The growing convergence of media formats, bringing with it the possibility of the integration of print, audio, video, and interactive elements with synchronous and asynchronous communication and links to the vast information resources of the Internet, suggests that understanding learner-interface interaction may likewise be increasingly important in conceptualizing learning online. In particular, it would be beneficial to have a better understanding of the specific learning benefits (and constraints) that can result from learner interactions with a variety of media and combinations of media within such environments.

Vicarious Interaction

In traditional classroom discussion, vicarious learning is the norm. An instructor poses a question and a student answers it. Perhaps the instructor leads the student to a deeper understanding of a concept, corrects a misconception, or helps the student clarify an idea. Thus in traditional classroom discussion, teacher-student interaction takes place a single student at a time, and yet we view such discussion as both highly interactive and an important part of the educational experience for all students. We do so because we believe that students who actively process these individual interactions will learn from them. Leah Sutton [146] argues that, even though online discussion is qualitatively different from face-to-face discussion, even though it encourages greater and more equitable participation, and even though the concrete record it produces might tempt us to forget what we can't see, the same principle applies to asynchronous discussion online. Sutton suggests that direct participation in online discussion is not necessary for all students all of the time. She further contends that those who actively observe and process both sides of direct interactions among others will benefit from that process which she calls "vicarious interaction".

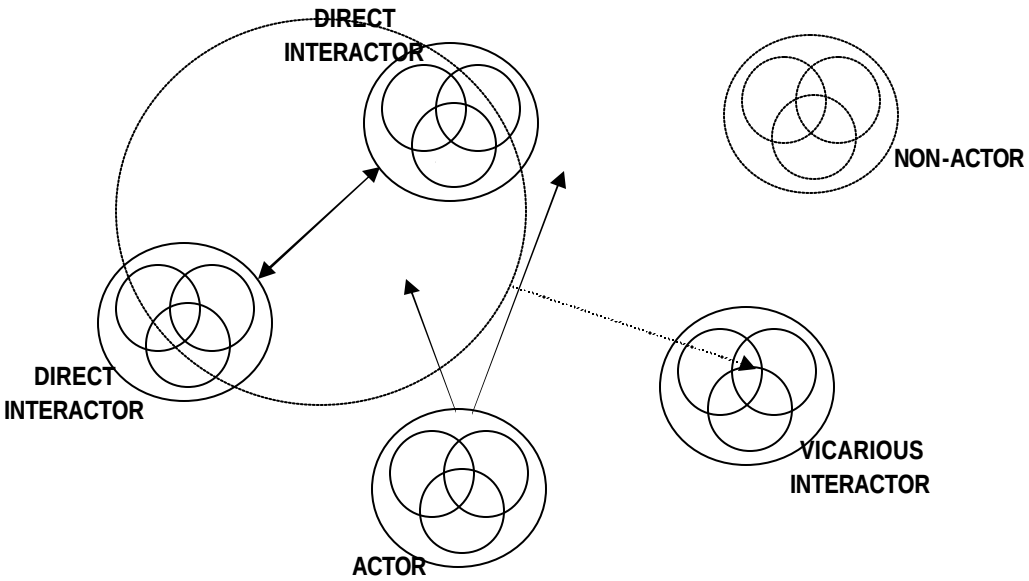

Figure 5: Four Types of Interactors (adapted from Sutton, 2001)

Indeed, in a pilot study of student behaviors in online discussion, Sutton [146] identified four different types of interactors that emerged from her data -- direct interactors, students who directly interacted with other students and/or the instructor; vicarious interactors; actors, students who provided unilateral input regardless of the reactions or comments of others; and non-actors, students who did not participate in the communication process. Figure 5 illustrates these types. Notice that direct interaction is reciprocal, and that vicarious interaction processes that reciprocity. For this reason, Sutton argues that students learn almost as much from vicarious interaction as from direct interaction, and more from vicarious interaction than from either action or non-action, by relating her findings to Bandura's [147] theory of observational learning. According to Bandura, observational learners go through four stages -- attention, in which a

learner analyzes and absorbs the behavior of a model; retention, in which the learner mentally represents that behavior; production, in which the learner overtly enacts the behavior; and motivation, in which the learner anticipates reinforcement. Direct interactors, Sutton maintains, go through all four stages as they process and respond to others messages and anticipate responses to their own. Vicarious interactors go through three of the four stages. They attend to and process their classmates messages, as well as anticipate reinforcement if only vicarious reinforcement. Actors, however, only produce without attending or processing. Actors, she argues, thus learn little from online discussion. Non-actors, of course, learn nothing.

Sutton [146] concludes that direct interaction in online discussion is not necessary for all students as long as they observe and actively process the interactions of others. In particular, she recommends vicarious interaction for students who are passive or reluctant to participate in overt interaction. Bandura's work [147] suggests another purpose. Bandura's theory of observational learning derives from his notion that novices learn by observing expert modeling. Thus, vicarious interaction might be particularly recommended to novices in to a field or a particular topic. In a similar vein, the notion clearly relates to the concept of legitimate peripheral participation, which Lave & Wenger [132] identify as an accepted way for novices to enter communities of practice. In their studies of informal learning within such communities, Lave and Wenger noticed that the initiation of new members was a gradual process that began with observation at the periphery of community activity and progressed slowly through increased levels of participation. Thus, vicarious interaction might also be a means of initiating new students to online programs. In any case, a better understanding of vicarious interaction in online discussion might make us better able certain kinds of learners.

Of course, all online discussion participants interact vicariously to greater or lesser degrees. Interestingly, there is some evidence to indicate that all such vicarious interaction plays a significant role in student satisfaction and learning. For example, Fulford and Zhang [13] explored the relationships between learners' perceptions of interaction and their satisfaction with distance courses delivered through interactive video. Their results indicate that students' perception of the general level of student-student and student-instructor interaction within classes had more influence on their satisfaction with them than did their perceptions of their own specific interactions. Similarly, when Helmut Fritsch [148] asked students enrolled in online distance education courses what parts of the courses they thought they learned the most from, they ranked their general reading of message postings higher than their own active participation in the discussion. Fritsch terms such vicarious interaction, "witness learning," and like Sutton [146], notes that it is an integral part of learning from face-to-face discussions. He is interested in how witness learning is enacted in online environments and how online instructors can support and enhance it. Such questions clearly deserve further study.

SUMMARY AND IMPLICATIONS

What does the research tell us about learning effectiveness in asynchronous online environments? On the one hand, it tells us that online environments support learning outcomes that are generally equivalent to those resulting from traditional, face-to-face instruction [16, 17, 18]. On the other hand, the research suggests that unique characteristics of the medium may afford and constrain particular kinds of learning [139]. Such affordances and constraints, in turn, suggest certain strategies and approaches that might enhance the learning effectiveness of online instruction. These are summarized in Tables 1 through 3 which connect what we know, or think we know, about learning in asynchronous online environments

with suggestions for practice that might either capitalize on unique their affordances or ameliorate their unique constraints.

RESEARCH FINDING	IMPLICATIONS FOR PRACTICE
Interactions with course interfaces are a real factor in learning; difficult or negative interactions with interfaces can depress learning.	Work with major platforms to improve interfaces to support learning. Develop consistent interfaces for all courses in a program. Provide orientations to program interffaces that help students develop useful mental models of them. Provide 24/7 support for students and faculty. Make human tutors available.
Greater clarity and consistency in course design, organization, goals, and instructor expectations leads to increased learning.	Review courses taught &/or being developed to insure clarity & consistency. Establish quality control guidelines that address issues of clarity & consistency. Address issues of course design & organization & instructional goals & expectations in faculty development.
Ongoing assessment of student performance linked to immediate feedback & individualized instruction supports learning.	Automate testing & feedback when possible. Provide frequent opportunities for testing & feedback . Develop general learning modules with opportunities for active learning, assessment & feedback that can be shared among courses &/or accessed by students for remediation or enrichment.

Table 1: Interaction with Course Interfaces and Content:
Research Findings and Practical Implications

Table 1 summarizes findings relating to interactions with course interfaces and interactions with content. Interactions with course interfaces relate to a constraint of asynchronous learning. In traditional, face-to-face classrooms, instructors and students can negotiate meanings in real time. This allows instructors to make goals and expectations clear and to remediate student misconceptions and confusions as they occur. In asynchronous courses, this kind of negotiation of meaning is not possible. In addition, course interfaces and course design add another layer of information students must make sense of. Thus, careful attention to these features in course design and implementation can make important differences in learning from online courses.

On the other hand, online environments can take advantage of the unique ability of the computing medium to respond to users and so individualize their learning according to their particular learning needs and styles [26]. Computers also can provide students with almost unlimited opportunities for active learning linked to immediate feedback and assessment which we know leads to improved learning outcomes. These capabilities of computers should be capitalized on.

Table 2 summarizes research findings relating to interactions with instructors in asynchronous learning networks and their implications for educational practice. Interactions with instructors are critical in all learning environments. They are perhaps more critical online [14, 49, 75]. Because there is no classroom in which students can connect with their instructors, instructor-student interactions must be made explicit. Frequent and supportive interactions with instructors, thus support online learning.

RESEARCH FINDING	IMPLICATIONS FOR PRACTICE
The quantity and quality of instructor interactions with students is linked to student learning.	Provide frequent opportunities for both public and private interactions with students. Establish clear expectations for instructor-student interactions. Provide timely & supportive feedback. Include topic of instructor interaction in faculty development.
Instructor roles are changed in online environments.	Include the topic of changing roles in faculty .development & provide examples of how other instructors have coped. Provide ongoing educational technology support for faculty. Develop forums for faculty discussion of changing roles – online & F2F.

Table 2: Interaction with Instructors:
Research Findings and Practical Implications

In addition, instructor roles are changed online [95]. In many ways, these changes have to do with the unique affordances and constraints of the environment itself. Instructors need to be clearer, to provide greater structure for their students, and to find new ways to express emotion and otherwise connect with students. In particular, instructors need to develop new ways to project teaching presence [94] in asynchronous online learning environments.

Figure 3 summarizes research findings and practical implications concerned with interactions among students in asynchronous learning networks, including those involving vicarious learning [146, 148]. Indeed, interactions among students through asynchronous discussion have been perceived by many authors to be the most unique, and so interesting, sources of learning in online courses [49, 66, 106, 107]. They view online discussion as more equitable and democratic and as more mindful, and reflective than discussions in face-to-face classrooms. Research also suggests that asynchronous learning environments might be particularly supportive of experimentation, divergent thinking, and complex understandings, and less supportive of convergent thinking, instructor directed inquiry and scientific thinking than face-to-face discussions [36, 37].

However, researchers remind us that learning through online discussion depends on the frequency, timeliness, and nature of the messages posted, hence on the value instructors put on it [12, 75, 110]. In addition, the development of social presence and virtual communities among discussion participants have been shown to support learning through online discussion. [34, 37, 74, 88].

RESEARCH FINDING	IMPLICATIONS FOR PRACTICE
Learning occurs socially within communities of practice; there is greater variability in sense of community ratings among online courses than in F2F courses.	Design community-building activities. Model the use of cohesive immediacy behaviors in all interactions with students. Develop initial course activities to encourage the development of swift trust. Address issues of community in faculty development.
Verbal immediacy behaviors can lesson the psychological distance between communicators online; overall sense of social presence is linked to learning.	Develop initial course activities to encourage the development of swift trust Model & encourage the use of verbal immediacy behaviors in interactions with students. Encourage students to share experiences & beliefs in online discussion. Introduce social presence & verbal immediacy in faculty development.
Student learning is related to the quantity & quality of postings in online discussions & to the value instructors place on them.	Make participation in discussion a significant part of course grades. Develop grading rubrics for discussion participation . Require discussion participants to respond to their classmates postings &/or to respond to all responses to their own postings. Stress the unique nature & potential of online discussion in faculty development.
Vicarious interaction in online course discussion may be an important source of learning from them.	Encourage & support vicarious interaction . Require discussion summaries that identify steps in the knowledge creation process. Use tracking mechanisms to reward reading as well as responding to messages.
Online discussion may be more supportive of experimentation, divergent thinking, exploration of multiple perspectives, complex understanding & reflection than F2F discussion.	Encourage experimentation, divergent thinking, multiple perspectives, complex understanding & reflection in online discussion through provocative, open-ended questions, modeling & support & encouragement for diverse points of view. Develop grading rubrics for discussion participation that reward desired cognitive behaviors . Develop initial course activities to encourage the development of swift trust.
Online discussion may be less supportive of convergent thinking, instructor directed inquiry & scientific thinking than F2F discussion.	Use other course activities to support these such as written assignments, one-on-one tutorials, small group collaboration & self-testing. Develop grading rubrics for discussion participation that reward desired cognitive behaviors .

Table 3: Interaction with Classmates and Vicarious Interaction:
Research Findings and Practical Implications

All of these areas of inquiry are young as online learning itself. Further research, more rigorous research, and more creative research into all of them is definitely needed. In particular, researchers should explore those unique characteristics of asynchronous online environments that matter or can be made to matter in learning and instruction. Robbie McClintock [149] writes, "Digital technologies are for education as iron and steel girders, reinforced concrete, plate glass, elevators, central heating and air conditioning were for architecture. Digital technologies set in abeyance significant, long-lasting limits on educational activity." We need to explore what new and wonderful kinds of learning asynchronous environments make possible.

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