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LEARNING ONLINE: A REVIEW OF CURRENT RESEARCH ON ISSUES OF INTERFACE, TEACHING PRESENCE AND LEARNER CHARACTERISTICS

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ABSTRACT
This paper introduces this section on learning effectiveness by exploring interesting themes in the recent research literature on that topic. In particular, it looks at studies of the effects of course interfaces, teaching presence, and learner characteristics on student learning in asynchronous online course environments. Significant effects of each of these elements on student learning are documented and explored, and significant interrelationships among them suggested.

KEYWORDS
online learning, interaction with interface, teaching presence, learner characteristics

This section explores learning effectiveness in asynchronous learning networks. Effectiveness in online learning has traditionally been defined in terms of face-to-face learning. The benchmark for quality has been that online learning is "at least equivalent to learning through an institution's other delivery modes, in particular, through its traditional, face-to-face, classroom-based instruction" [1]. Measures of learning have typically included general performance measures, such as exam and project scores and/or course grades [2, 3, 4, 5, 6], and teacher [7, 8, 9] and student perceptions of learning [10, 11, 12, 13].

More recently, however, authors have noted that by striving to make online learning "as good as face-to-face," we may be overlooking, even sacrificing, its distinct potential [14, 15]. Thus, some researchers have focused on aspects of online learning they view as unique, such as personalization [14], support for reflective inquiry [16], interactivity [17, 18], and support for collaboration [19, 20]. Indeed, more recent studies that do compare online learning to learning in traditional environments have begun to focus on the how the unique qualities of asynchronous environments work to support or constrain learning relative to traditional classroom environments [21].

Research on online learning has also begun to focus more on specific facets of online learning and the complex interactions among them. The papers in this section are good examples of this trend. In this introduction to them, I explore recent research on learning effectiveness in three areas that seem particularly promising, research that has caught my eye and my imagination in the past year. These include studies of interface issues, investigations of teaching presence, and research on learner characteristics. All three topics seem to have important implications for effective practice as it relates to

learning within online environments. Perhaps more importantly, all three seem intricately connected in complex ways whose unraveling might have much more important practical import.

ISSUES OF INTERFACE

Quite a long time ago in digital years, Michael Moore [17] identified three kinds of interactivity that affected learning online -- interaction with content, interaction with instructors, and interaction among peers. Not long after, Hillman, Willis, and Gunawardena [22] 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 mediate a particular distance education process. Interactions with interfaces thus refers to the use learners must make of specific technologies, platforms, applications, and course templates to interact with course content, instructors and classmates (Figure 1). Ten years later, interfaces no longer represent the kinds of barriers to interaction they once did, but it is becoming increasingly clear that interactions with interfaces significantly afford and/or constrain the quality and quantity of the other three interactions [23].

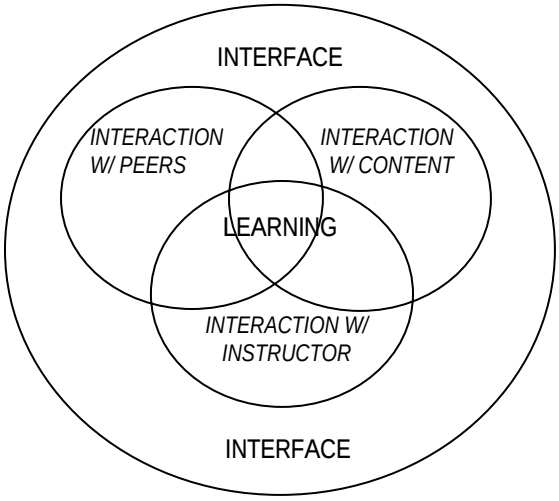

Figure 1: Interaction with Interface Conceptualized
Swan, 2003

A particularly compelling example of the influence of interface on online learning can be found in Jim Hewitt's studies of patterns of development in online discussions [24, 25]. Hewitt explored patterns of interactivity in 673 multi-message threads found in the online discussions of 92 graduate students enrolled in five asynchronous online courses [24]. For example, there were 344 four message threads in the discussions Hewitt sampled. In a four message thread, there are six possible patterns (Figure 2; numbers indicate sequence in time, indentations indicate responses to a previous posting). One might expect a reasonably equal distribution of these patterns across the sample, yet he found nearly three times as many instances of the elongated pattern (F) as any of the others, and few instances of both the truncated pattern (A) and the sequence that was out of temporal order. He found similar frequencies of patterns in the other (longer and shorter) threads in the sample.

Hewitt attributed these disparities to students' habits of participation in online discussions, habits he maintains are encouraged by the design of discussion interfaces to flag unread notes. Indeed, when he investigated user logs, he found that most students (97.6%) read messages before they posted messages, read only messages flagged as unread (82%), and tended to respond to messages that were less than 48

hours old (80%). In a follow-up study [25], Hewitt found that these patterns of interaction could be replicated using a Monte Carlo simulation based on nothing more that typical rates of reading and posting messages and a rule which stated that only messages flagged as unread would be responded to.

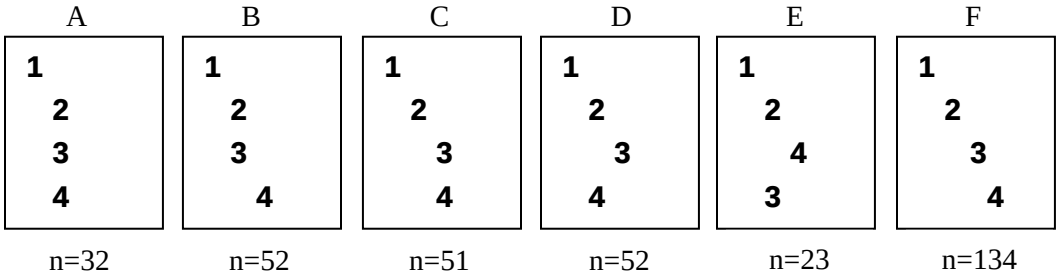

Figure 2: Frequencies of Patterns of Interaction in Four Message Threads adapted from Hewitt, 2003

Hewitt [24, 25] concluded that patterns of interactivity in online discussion were clearly influenced by interfaces that flag messages as unread and only display a single message at a time to favor elongated threads and discussions he characterizes as growing like forest fires, at the edges. The problem with this, he observes, is that potentially interesting and important threads are unintentionally abandoned, and that unintentional changes in topic supplant central themes, resulting in disjointedness and discussions that are often peripheral to course content. He suggests experimenting with differing interfaces and/or discussion assignments to support more meaningful learning. His results demonstrate the powerful mediating effects of interface design on learning through online course discussions.

Another interesting focus in research on the effects of interface design on student learning involves the growing use of a variety of media to deliver course content. Researchers, designers and practitioners of online learning are beginning to ask what combinations of text, pictures, animations, audio and video best support student learning. Richard Mayer [26] has been studying these issues for the past fifteen years in experimental studies of students' understanding and transfer of scientific explanations. In over 20 separate investigations, Mayer and his colleagues meticulously tested what combinations of multimedia resulted in the greatest transfer of learning.

For example, Mayer [26] randomly assigned students to interact with two versions of a computer-based explanation of the phenomenon of lightning, one in which animations depicting lightening generation were accompanied by textual explanations and one in which the same animations were accompanied by narrations explaining them. Student performances on tests of their ability to transfer their understanding were compared between groups and significant differences favoring animation with narration were found. Mayer made similar comparisons of the effects of differing combinations of media and variations in the sequencing and organization of multimedia presentations on such topics as human respiration, automotive braking, airplane lift and plant growth on transfer of learning, and replicated his results multiple times in all cases. Findings from this work are summarized in Table 1 which shows both findings from this work (research effect) and suggests practical applications of the findings (design principle).

	RESEARCH EFFECT	DESIGN PRINCIPLE When designing multimedia, . . .
MODALITY	better transfer from animation and narration than from animation and text	. . . present explanations of animations in spoken form.
CONTIGUITY	better transfer when narration and animation are presented simultaneously rather than sequentially	. . . present narration and animation simultaneously.
MULTIMEDIA	better transfer from animation and narration rather than from narration alone	. . . provide narration for animations.
PERSONALIZATION	better transfer when narration is conversational rather than formal	. . . present narration in a conversational style.
COHERENCE	better transfer when irrelevant video, narration, and/or sounds are excluded	. . . avoid extraneous video and audio.
REDUNDANCY	better transfer from animation and narration than from animation, narration and on-screen text	. . . do not add text to presentations involving animations with narration.
PRETRAINING	better transfer when explanations of system components precedes rather than follows a narrated animation	. . . begin explanations with concise descriptions of system components
SIGNALING	better transfer when different parts of a narration are signaled	. . . include signaling that identifies the organization of the presentation.
PACING	better transfer when the pace of presentation is learner controlled	. . . allow the learner to have control over the pace of the presentation.

Table 1: Effects and Principles of Multimedia Design
adapted from Mayer, 2001

Chi-Hui Lin [27] did a similar experimental study of the effects of differing multimedia presentations on student learning, but with an added twist. Lin categorized subjects' epistemological beliefs as either mature or naïve on four dimensions -- First Time Learning, Omniscient Authority, Quick Learning, and Simple Learning, and then compared their learning of mathematical concepts from online instructional materials that included either static graphics, animations or video representations. Results of a two-way ANOVA with performance as the dependent variable showed a main effect for graphical representation -- students given the animations outperformed students shown video, but no effect for epistemological beliefs, and no interactions between representations and epistemology. However, when attitudes towards learning were used as the dependent measure, a main effect for epistemological beliefs (students with mature Quick Learning beliefs, those who believe that learning takes time, outperformed students with naïve Quick Learning beliefs) and very interesting interactions between graphical representations and epistemological beliefs were revealed. Lin found that among students interacting with instructional materials containing animations, those with mature Omniscient Authority beliefs (those who believed that learning results from the work of the learner) had better attitudes toward learning than

students with naïve Omniscient Authority beliefs (those who believed that learning results from the work of a teacher). The opposite was true among students interacting with instructional materials containing video illustrations. A similar interaction was found on the Simple Learning dimension. Lin's work provides an intriguing glimpse into interactions between interface design and learner characteristics, and suggests that this may be a rewarding area for future research.

Other research on the effects of interaction with online interfaces involves the design of particular interfaces. For example, Chang, Sung and Chiou [28] investigated the efficacy of a hierarchical hyper-concept map (HHCM) interface as compared with a simple hierarchical navigation system and a linear course presentation for supporting junior high students learning of computer concepts. The hierarchical concept map organization provided students with a navigable representation of the structure of each unit of study as well as a hierarchical representation of the units (simple hierarchical navigation). The linear presentation provided no meta-indexing of the instructional materials. Chang, et al also tested and categorized students as field dependent/independent to see whether this might affect the effects of the various treatments. Using analysis of covariance, with GPA as the covariate to partial out the effects of general aptitude, the researchers tested the effects of interface and field dependence/independence on two dependent measures, a test of computer hardware achievement (CHAT) and logs of time students spent using the online materials. Although field independent students significantly outscored field dependent students on performance measures, no interaction between field dependence/ independence and interface designs was found. In addition, the HHCM group scored significantly better than the linear group on performance measures, and took significantly less time reading the materials than students in both the linear group and the hierarchical navigation group. The authors argue that the results suggest that students learned faster and slightly better from the HHCM interface.

Another study of a particular interface design was conducted by Gutl and Pivec [29] to explore the efficacy of a Virtual Tutor (VT) application for scaffolding the problem solving of undergraduate computer science students. The VT combined capabilities for multimedia representation with an expert system to provide problem solving support for students learning computer programming. The authors compared the problem solutions of students randomly assigned to work either using the VT or using traditional print resources. Although the sample size was too small for statistical comparisons (n=21), they report that all the VT students (n=11) provided correct solutions to a transfer problem, whereas two of the students working with print materials provided incorrect solutions and two provided incomplete solutions. In addition, students working with the print materials experienced time problems, while students working with the VT did not. The authors argue that the results show that students solved problems better and faster using the Virtual Tutor. Because both this study and the Chang, et al study reported above explore design concepts as well as particular implementations, their results may suggest ways in which interfaces can be designed to better support student learning. It is worth noting that the interfaces advocated in both studies exploit the unique capabilities of online computing environments.

Two studies that explored both interface and teaching presence issues also deserve mention. Both studies compared instructor-provided feedback on assignments with web-based model comparison types of feedback and both argue for the superiority of instructor-provided feedback. Riccomini [30] investigated pre-service education students' application of behavior-analysis and instructional-analysis skills on criterion tasks after receiving either instructor-delivered corrective feedback on a similar task or being directed to a web-based exemplary model that students could then compare with their own solutions to the task. Riccomini used an experimental, counter-balanced design in which students were randomly assigned to groups who received one type of feedback for one of the tasks and the other type of feedback on the other. He found that students receiving instructor delivered corrective feedback significantly outscored students using web-based model comparison feedback on both tasks.

Researchers at Michigan State University [31] made a similar comparison of instructor-delivered and web-based assignment feedback. This is an interesting study because it examines learning from real-world, web-based applications. The Michigan State physics department created a program to generate individualized homework assignments. In response, former students created a web application that generated answers with explanations to those problems. This study compared the performances of students using this third party site for help with their homework with those of students who took advantage of an instructor supported discussion site where they could get help on their homework from graduate assistants (GAs). The researchers further distinguished between students who posted to the instructor supported discussion, and students who just read those discussions. Using correlational analyses, they examined the relationships between the use of each of the online homework support sites and students' grades on homework, quizzes, and midterm and final exams, with the effects of aptitude (operationalized as composite ACT scores) partialled out. They found positive correlations between posting to the sanctioned site and grades on homework, midterm, and final exams, and between visiting the sanctioned site and grades on midterm and final exams. Interestingly, there was a negative correlation between just visiting the sanctioned site and homework grades. On the other hand, there was a positive correlation between using the third party site and homework scores, but negative correlations between using that site and grades on quizzes, midterms, and final exams. The results of this and the previous study indicate that web-based explanations of homework may not support conceptual learning without instructor interaction (teaching presence), at least with undergraduate populations. The authors of both studies suggest that individualized interrogation of students' conceptual understandings and remediation of misconceptions were what led to greater learning in the instructor-supported conditions. They further note that the students in their studies may not have been able to make needed comparisons between their own work and the exemplars provided. Further research in this area could prove fruitful. In particular, considering the Virtual Tutor results, it might be interesting to make comparisons between instructor-supported feedback and expert system feedback.

Finally, researchers at the National Technical University of Athens (NTUA), Greece have developed a survey instrument that specifically looks at the effectiveness of interfaces for delivering instruction and supporting learning [32]. CADMOS-E is a stepwise evaluation method that uses pre- and post-course surveys and regression analysis to assess the learning effectiveness of a delivery ststem in terms of: quality of the learning resources, changes in preferred mode of study, computer-mediated interactions with peers and instructors, contribution of web-based learning resources to the acquisition of knowledge and skills, and time spent with the learning resources, while factoring in such learner characteristics as previous computer experience and learning styles. The researchers used CADMOS-E to evaluate the effectiveness of an online course in software engineering offered at NTUA, then redesigned the course based on their initial findings, and re-evaluated the redesigned course. In the first evaluation, the authors found that the greatest amount of the variance in learning effectiveness could be attributed to "contribution of the web-based resources to the acquisition of knowledge and skills" (28%), followed by "changes in preferred mode of study" (11%) and interaction with the instructor (9%). In the second evaluation, they found "contribution of the web-based resources to the acquisition of knowledge and skills" again to be the greatest contributor to the variance in learning effectiveness, this time accounting for 37.5% of the variance, followed by "changes in preferred mode of study" (15%) and "time spent with the learning resources" (4%). The authors attribute the increased importance of the "contribution of the web-based resources to the acquisition of knowledge and skills" in the second study to improvements made in course design as a result of the first evaluation. It is also interesting to note that that "interaction with the instructor" declined in importance in the second study to where it was no longer a predictor variable. These findings may suggest that careful course design may take over some aspects of teaching presence from course instructors and help lessen the well documented burdens of online teaching. In any

case, the instrument and its application to the redesign of course materials and interfaces seems very promising and a direction that might well guide both research and practice in the future.

TEACHING PRESENCE

Anderson, Rourke, Garrison and Archer [33] coined the term "teaching presence" to refer to "the design, facilitation and direction of cognitive and social processes for the purpose of realizing [students'] personally meaningful and educationally worthwhile outcomes." Anderson, et al. conceive of teaching presence as composed of three categories of activities – course design and organization, facilitation of discourse, and direct instruction. While they ascribe much of this activity to the work of instructors, they recognize that it also can be accomplished otherwise, through interaction among students for example, or, as suggested above, through clever interface designs [29, 32]. Kashy, et al [31] and Riccomini's [30] findings concerning the superiority of interactive instructor supported corrective feedback over static and general exemplars, however, suggest that we must be very careful in considering how teaching presence is mediated through course interfaces. At the very least, they suggest that interaction is a critical element in meaningful feedback.

Indeed, many scholars maintain that online learning can support greater interaction between teachers and students than is typically found in face-to-face environments and argue that for this reason they can also support more meaningful learning [34]. Gutl & Pivec's [29] work, in this vein, perhaps suggests ways in which course interfaces might be designed to extend teaching presence. The research of Bures, et al [35] on motivation and Davies [36] on intentionality likewise indicates how teaching presence can interact with learner characteristics to support or constrain learning, as does the work of Gunn and McSorran [37] on gender and Morse [38] on culture (see following section on learner characteristics). Clearly, current work on the effects of various aspects of online learning is uncovering a variety of evidence that points to complex interactions among such aspects. Central to this complexity, is the notion of teaching presence.

For example, an ongoing study at the SUNY Learning Network (SLN) provides substantial evidence of the focal relationship between teaching presence and student satisfaction with and perceived learning from online courses [39, 40]. Basing their studies directly on the categories and subcategories of teaching presence identified by Anderson, et al [33], SLN researchers used end-of-term survey data from summer (n=1,150), and fall, 2003 (n=6,088) to explore correlations between students' perceptions of teaching presence and their satisfaction and perceived learning from online courses. The authors found significant correlations between all measures of teaching presence, both that the teaching presence of their instructors and, interestingly, that of their fellow students, and students' satisfaction with and perceived learning from online courses.

Specifically, Anderson, et al [33] identified five indicators of teaching presence in the design and organization category (setting curriculum, designing methods, establishing time parameters, utilizing the medium effectively, and establishing netiquette), six indicators for facilitating discourse (identifying areas of agreement and disagreement, seeking to reach consensus and understanding, encouraging, acknowledging, and reinforcing student contributions, setting the climate for learning, drawing in participants and prompting discussion, and assessing the efficacy of the process), and seven indicators for direct instruction (presenting content and questions, focusing the discussion on specific issues, summarizing discussion, confirming understanding, diagnosing misperceptions, injecting knowledge from diverse sources, and responding to technical concerns). Shea et al [39, 40] asked students to respond to questions concerned with each of these subcategories using a five-point Likert type scale ranging from disagree strongly to agree strongly, eg "Overall, *the instructor* for this course provided clear instructions

on how to participate in course learning activities (for example, provided clear instructions on how to complete course assignments successfully)." Questions concerning the facilitation of discourse and direct instruction were presented with respect to both the instructor and other students, eg. "Overall, *other participants* in this course helped to keep students engaged and participating in productive dialog." The researchers collapsed and averaged scores for each category of teaching presence, then correlated these with students' reported satisfaction with and learning from their courses. The results of these analyses are given in Tables 2 and 3 below.

CATEGORY (of teaching presence)	SUMMER, 2002				SPRING, 2003			
	satisfaction		perceived learning		satisfaction		perceived learning	
	r	p	r	p	r	p	r	p
design & organization	.64	< .01	.59	< .01	.64	< .01	.60	< .01
facilitating discourse	.64	< .01	.58	< .01	.61	< .01	.58	< .01
direct instruction	.64	< .01	.61	< .01	.63	< .01	.61	< .01

Table 2: Correlations between Teaching Presence of Instructors and Student Satisfaction & Perceived Learning Shea, Fredericksen, Pickett, & Pelz, 2003; Shea, Pickett & Pelz, 2003

CATEGORY (of teaching presence)	SUMMER, 2002				SPRING, 2003			
	satisfaction		perceived learning		satisfaction		perceived learning	
	r	p	r	p	r	p	r	p
facilitating discourse	.36	< .01	.37	< .01	.41	< .01	.43	< .01
direct instruction	.39	< .01	.39	< .01	.40	< .01	.43	< .01

Table 3: Correlations between Teaching Presence of Students and Student Satisfaction & Perceived Learning Shea, Fredericksen, Pickett, & Pelz, 2003; Shea, Pickett & Pelz, 2003

As seen above, the results demonstrate a strong correlation between the teaching presence of instructors and student satisfaction and perceived learning. Perhaps even more interesting are the more moderate correlations found between the teaching presence of fellow classmates and student satisfaction and perceived learning. These findings indicate that teaching presence is indeed distributed across online interactions as indicated by Garrison, et al's [41] model. Although Shea et al's findings [39, 40] relate teaching presence to *perceived* learning only, the data used was derived from large and diverse population enrolled in courses at all academic levels in different topic areas, and offered through multiple institutions. The similarity of results across semesters also points to their robustness. Further investigation of the relationship between teaching presence and learning is clearly indicated, especially research linking teaching presence to actual performance data, and research investigating the complex interrelationships among interactions with instructors, peers, interfaces, and course content.

Two other recent articles concerned with teaching presence and online discussion also deserve mention for their intriguing refinements of the concept. In a case study of the development of an interpretive community in an online graduate course on gender and culture in children's literature, Kay Vandergrift [42] develops the concept of "restrained presence" and its importance in the development of community. Vandergrift describes restrained presence as the instructor's refraining from comment in discussion to let

students find and voice their opinions. She writes, "A faculty role that balances restraint and presence seems to encourage students to make the online class their own." Amy Wu [43], in a theoretical article on the application of constructivist principles to support online discourse, seems to argue for a similar restrained instructor role as well as for the use of the principles of collaborative learning in the facilitation of course discussions. Specifically, she recommends structuring peer interaction around authentic tasks, applying questioning strategies, role assignment, interdependent assessment, and requiring student reflection on the discussion itself. In Wu's view, the role of the instructor in all of this is to facilitate student collaboration by providing appropriate structures, not to direct the discussion. Wu's notion of the collaborative structuring of online discussion brings to mind Hewitt's findings [24, 25] concerning interface issues and perhaps suggests some ways discussion interfaces might be designed to better support learning.

Vandergrift [42], Wu [43] and Shea, et al. [39, 40], as well as many others, recommend specific training in teaching presence for all online instructors. Such recommendation is clearly a good one. Research on the effects of such professional development on teaching presence and student learning would be very useful. Research further refining our understanding of teaching presence is also indicated. Further investigation of this interesting concept would surely increase our understanding of the seemingly symbiotic relationship between interactions with instructors, peers, and course interfaces and their mutual effects on the learning of course content.

LEARNER CHARACTERISTICS

Distance educators have long been concerned with the effectiveness of online learning for all students. As more and more programs are put online, questions of whether or not asynchronous online learning might be differentially effective for different kinds of students have become more critical. Dziuban & Dziuban [44], for example, developed a measure of online learning style based on Long's work [45] in adolescent psychology, the Long-Dziuban Reactive Behavior Protocol, which classifies students along two dimensions: aggressive/passive and dependent/independent. The aggressive/passive dimension has to do with the energy students bring to the learning experience. Aggressive learners are very active, passive learners are not. The dependent/independent dimension has to do with control of learning and need for approval. Dependent learners have a greater need for approval than independent learners who tend to want to control their own learning. In an interesting study of attrition among online students at the University of Central Florida, the researchers found that students who dropped out of online classes were almost exclusively dependent. The findings suggest that success in online courses is, in an important sense, related to students' need, or lack thereof, for instructor approval. They thus have implications for research on teaching presence as well as for research on learner characteristics and learning effectiveness. Katrina Meyer [46] similarly reports that students with independent learning styles are more likely to succeed in online courses than students with dependent learning styles. She further maintains that visual learners are more successful online than aural and/or kinesthetic learners, and that students with high motivation, greater self-regulatory skills, greater self-efficacy concerning online learning and better computer skills are more likely to perform well in online courses than students without these characteristics. One wonders why learners with specific characteristics outperform others or persist when others don't. Learning effectiveness research should certainly explore this question and its corollary, how can we better support all kinds of learners online. This latter question again overlaps issues of interface and teaching presence.

While Aragon, Johnson & Shaik, N. [47] found no differences in the performance of online students as determined by three different learning style measures -- Grasha and Reichmann's Student Learning Style Scale (SLSS) [48], Weinstein, Palmer, and Schulte's Learning and Study Strategies Inventory (LASSI) [49] and/or Kolb's Learning Style Inventory (LSI) [50], they did find significant differences in learning styles as determined by Kolb's LSI between traditional, face-to-face students and online learners. Online students were more likely to prefer reflective observation and abstract conceptualization, while face-to-face learners were more likely to prefer active experimentation. In an analogous comparison of the characteristics of online and face-to-face students enrolled in a community college in the Chicago area, Halsne & Gatta [51] found that the online learners had several distinguishing characteristics. They were predominately visual learners, whereas traditional students were primarily auditory or kinesthetic learners. Online learners spent, on average, an hour more per week on classwork than did their traditional student counterparts. The results also indicated that online students were typically older, whiter, richer, and more likely to be women than their face-to-face counterparts. They were typically full-time, professional workers and part-time students, as compared with traditional students who were more likely to be full-time students with part-time, service-type jobs. While some of these differing characteristics in online and face-to-face populations clearly involve self-selection relative to accessibility needs, some may be related to performance, or perceived performance, needs. Learning style and media preference characteristics, for example, clearly might have implications for interface design. These certainly deserve further investigation.

Indeed, learner characteristics and their effects on learning in online environments is a important topic in online learning research. While findings in this area are preliminary, they are plainly intriguing. In the previous discussion of interface issues, findings linking success in online learning to field independence [28] and attitudes about online learning to epistemological beliefs [27] were reviewed. Another interesting study by Nachmias & Shany [52] found differences in both learning and attitudes towards learning among middle school students with differing thinking styles as defined by Sternberg's theory of mental self-government (global/local, internal/external, liberal/conservative) [53]. Subjects were 110 eighth and ninth graders enrolled in an online course on web searching. The researchers measured students' performance in terms of grades, successful web searches, completion of assignments, and use of asynchronous communication. Attitudes were assessed by survey responses concerning course satisfaction and attitudes toward the online learning process. T-test analyses revealed that students with liberal and/or internal thinking styles outperformed students with conservative and/or external thinking styles as measured by grades, successful web searches and completion of assignments. Students with liberal and/or internal thinking styles also were more positive about the online learning process. Correlations between performance and attitudinal variables were also found, as were some correlations between these and prior Internet experience. Interestingly, no correlations were found between any variables and gender. These findings may mirror those of Dziuban & Dziuban [44], Meyer [46], Chang, et al. [28] and Lin [27] with a much younger population, indicating perhaps their significance. They certainly deserve further investigation.

Bures, Aundsen & Abrami [35] investigated relationships between student motivation and student acceptance of learning via computer conferencing, operationalized as frequency of contributions to online discussions, satisfaction with computer conferencing, grades, and time spent online. Both trait (individual characteristics) and state (task-related) motivation variables were explored. Subjects were 167 undergraduate students in ten courses chosen at random from online offerings at multiple universities. The researchers found that students with a learning (vs. performance) orientation spent more time on online activities and got higher grades. Regression analyses revealed that trait motivation variables explained 23.5% of the variance in satisfaction with computer conferencing, while state motivation variables explained 16.7% of the variance, and that the introduction of state motivation variables improved the model. Similarly, trait motivation variables explained 7.9% of the variance in time spent on online activities, and that, while not significant predictors, state motivation variables improved the model.

These results suggest not only that individual motivation can be an important factor in online learning, but that task specific states of motivation affect online learning. The authors conclude that course developers and instructors should encourage students to pursue mastery learning goals (learning orientation) and design activities that are personally relevant to students (state motivation). Again, the findings suggest that learner characteristics interact with interface and teaching presence issues to affect learning.

Similar conclusions were reached by Davies [36] who studied learner intentionality in online courses by communicating weekly via email with 20 undergraduate students enrolled in an online course. The author also interviewed all students face-to-face at the end of the semester. He found that the students he studied had two kinds of intent: learning and course completion. These correspond with learning orientation and performance orientation in the Bures, et al [35] study. Davies found that learning intent was by far more energizing for students, but that course completion superceded learning when deadlines approached. He also found that the students he studied did not take online courses as seriously as face-to-face courses, often believing them to be easier, and so sometimes put off studying for them. He concludes that online courses should not inadvertently promote course completion as a primary goal, nor should they be too easy. Rather he suggests promoting learning intent, possibly through asking students to reflect on their own learning. These findings, and those of Bures, et al, [35] are supported by Duane Grady's [54] content analysis of online discussions. Grady used an interesting methodology that involved a semantic analysis program, Diction 5.0, to explore the use of terminology in online discussions. He found that the top performing students and the top performing teams in a graduate level course in economics consistently used language that was more enthusiastic, determined and committed than that of low performing students and teams, whose language expressed low accomplishment, low activity and hardship. Because motivation seems to play a significant, perhaps a particularly significant role in online learning, these finding clearly need further investigation as do related issues of interface design and teaching presence.

Of special interest in research on learner characteristics are issues of gender, ethnicity, culture and language, in particular, whether specific classes of people are disadvantaged by online environments, and if they are, how such disadvantages might be ameliorated. For example, as noted above [51], women are more likely than men to be online learners, but Blum [55] among others suggests they may be disadvantaged relative to male learners by a lack of technical skills, a corresponding lack of computer self-efficacy and male dominance of online discussions. An intriguing paper by Cathy Gunn and Mae McSporran [37] provides evidence, based on their research and the research and experience of several colleagues, which supports Blum's findings, but also indicates that women's lack of technical skills and computer self-efficacy may result in women working harder and getting better grades in online courses than men. Gunn and McSporran further report corollary findings indicating that online learning works particularly well for women and mature students, and less well for younger male students. The authors suggest that overconfidence may be a problem for younger males and that it might make sense to find ways to help younger males get assistance and keep up with their coursework. This suggestion parallels the work of Davies [36] on intentionality and may point to ways in which learner characteristics, interface design, and teaching presence interact to support or constrain learning, as well as ways of ameliorating such tendencies. It also may suggest reasons why research investigating gender differences in learning in online environments has reported very mixed results. It may be that gender really is not a factor but that underlying variables sometimes associated with gender are.

The increasing internationalization of online courses leads to questions concerning differences in the perception of online learning among students from differing cultures. Although very little research has been done in this area, Morse's [38] exploratory study in this area is based on a characterization of learners that may prove useful for both research and practice. Morse characterizes cultures, according to Hall [55], as falling along a continuum running from low to high context. In low context cultures, low

levels of mutually understood information provide communication context, therefore, communication requires a large amount of explicit information to convey meaning. In high context cultures, high levels of mutually understood information provide context and listeners do not need to be given much background information. Western cultures tend to be low context. Western educational environments are correspondingly learning centered and emphasize the development of personal skills and attitudes as well as content learning. Eastern cultures tend to be high context. Eastern educational environments are correspondingly teaching centered and emphasize content and knowledge acquisition. Morse explored the effects of such differences on student perceptions of the advantages and disadvantages of online learning among students enrolled in an online graduate seminar. Subjects (n=24) were evenly split between low and high context backgrounds. Interestingly, students from both groups perceived similar disadvantages and ranked them similarly in importance. All students had difficulty reading computer material, found certain student postings too lengthy, and found following online discussions time consuming. On the other hand, while low context students reported the advantages of online learning to be personal convenience, time to reflect on others' opinions, and time to think about their own contributions, in that order, high context students found the ability to say what they thought as the greatest advantage in online learning, followed by the ability to think about their own contributions, and personal convenience. The author concludes that "the perceptions are based on learning patterns which are developed as part of a participants' ethnic/cultural development, and are potentially challenged by participation in an asynchronous communication network, which of itself is implicitly culturally based" (p. 51). She suggests that greater awareness of such differences might lead to better communication for all participants. The point is well-taken. Research in this area is clearly needed and it may be that, at least in this preliminary stage, distinguishing online learners by cultural background along a high/low continuum may be more useful than distinguishing them by native language.

SUMMARY AND DISCUSSION

In this paper, the effects of interface design, teaching presence, and learner characteristics on student learning in online courses were explored and found to be both significant and meaningful. In all three areas, empirical findings clearly demonstrate that course interfaces, teaching presence, and learner characteristics affected the quality of students' learning online.

The research reveals that a common feature of most discussion interfaces, the flagging of unread messages, profoundly affects the shape online discussions take [24, 25], and so, one would assume, the kinds of learning that takes place therein. It shows that particular media and combinations of media are more supportive of online learning than others [26, 27, 28], as are specific instructional sequences [26] and particular navigational interfaces [28]. It establishes the fact that interfaces matter [32], and suggests that they may matter a great deal to learning online. Indeed, my guess is that current research has exposed just the tip of the iceberg. The research also clearly demonstrates that teaching presence matters in online learning; in particular, it highlights the significance of interactions that scaffold student learning [30, 31] such as individualized corrective feedback and support for problem solving. The research further suggests that such scaffolding is shared across instructors, course designs, and learners themselves [27, 39, 40, 42, 43]. We need to better understand this distribution. Concepts like restrained presence and structured facilitation may help guide us in fruitful directions.

The research identifies specific learner characteristics (i.e. field independence [28], high motivation [35, 36, 37], high self-efficacy [46], mature epistemological beliefs [27]) and particular learning styles (i.e. visual [46], independent [44, 46], internal [53], liberal [53], intentional [35, 36, 54], self-regulated [46])

that are more supportive of learning online than are other learner characteristics and learning styles. Many of these are also supportive of face-to-face learning, but some are unique and some seem magnified in online learning. All can be improved through various means with varying degrees of success. Certain learner characteristics, however, such as gender and culture cannot be changed. Thus, whether these findings reflect something intrinsic to the online learning medium or simply current features of common interfaces and teaching practices is critically important. Which brings us to a last, but by no means least, finding embedded across the results reviewed here. It is simply that these observed effects are interrelated in a web of complex relationships. Interfaces interact with teaching presence interacts with learner characteristics and more, in ways we are just beginning to explore, let alone understand. Unraveling these relationships and developing models of learning online will not only increase or understanding of learning online but of understanding of learning in general and so improve the practice of online teaching and learning.

Issues of interface, teaching presence, and learner characteristics, are certainly important ones for understanding and improving online learning. They also clearly overlap. Indeed, all three of these concepts are touched on in the papers which follow. In the first, Zheng Yang investigates e-learning as a psychological phenomenon. Drawing on the work of authors from his upcoming special issue of the *Journal of Educational Computing Research*, Yang argues for the application of a variety of psychological approaches and conceptual frameworks to the study of online learning. He also makes a case for more empirical and more interdisciplinary studies of the psychology of e-learning. In the second paper, Michael Danchak describes a very intriguing interface he is working on that differentially presents information to students based on their learning style as identified on Kolb's LSI [50]. He calls his interface the Adaptive ExplanAgent and has found initial tests of the concept encouraging. Danchak's research and development work provides a concrete example of how interfaces of the future might be designed to adapt teaching presence to learner characteristics. In the final paper in this section, Roxanne Hiltz, Ben Arbaugh, Raquel Benbunan-Fich, and Peter Shea provide a thorough conceptual review of the research on the influences of contextual factors, including interaction with interfaces, learner characteristic, and teaching presence, on learning in asynchronous environments, and offer thought provoking directions for future investigations.

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