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ABSTRACT

Online discussion has been well established as a fundamental tool for collaborative e-learning and by extension for organizational knowledge management. Yet, in its current generation its effectiveness is limited by the enabling technology on which it is based. Applying Media Synchronicity Theory, potential benefits are envisioned, particularly in the case of collaborative learning environments, from incorporating emerging technologies toward a next-generation online discussion facility that provides a more expressive and responsive platform for collaborative learning. The potential benefits of pen-based computing, 3-D user interfaces, speech recognition, and layered rich media content are explored. At the same time, a number of challenging issues must be addressed in designing such an environment to ensure user acceptance and to maximize realization of the potential. Exploring this conceptualization serves to help surface both the opportunities and the challenges associated with such environments.

Keywords

Media Synchronization Theory, rich media, layered content, mobile computing, distributed collaboration, pen-based computing, speech recognition, 3-D interfaces.

INTRODUCTION

Though highly evolved from its "bulletin board" origins in terms of appearance and usability, threaded discussion thrives today as one of a handful of successful Web paradigms for the same reason as did its primitive predecessor in the first era of network computing: it represents the natural expression of the Internet as a platform for virtual communities. Users have embraced the medium for a variety of specific reasons. The Web casts a wide "net" that can bring together like-minded individuals of highly specialized interests who would otherwise be isolated by their geographical sparseness. Online discussion provides a relatively safe environment for expression, affording various degrees of identity concealment, egalitarian participation policies, etc. Underlying it all however, is the fundamental power of the one-to-many/many-to-one effect by which each participant, at the same time, both contributes to and partakes of the evolving collective wisdom of the community.

This phenomenon has not been lost on the educational community as online discussion has been widely embraced as an essential e-learning tool (2001). A standard component of leading commercial e-learning support environments, like WebCT and Blackboard, since their inception, online discussion has been found to yield a variety of benefits such as enhanced perceived learning (Wu and Hiltz, 2003). As a vehicle for the collection and formulation of collective wisdom, it is ideally suited to collaborative learning by which knowledge is synthesized as shared meaning (Leidner and Jarvenpaa, 1995). Indeed, based on Media Synchronicity Theory (MST) (Dennis and Valacich, 1999), a refinement of Media Richness Theory (Daft and Lengel, 1986), it can be argued that online discussion can be equally, or perhaps even more effective than its face-to-face counterpart under certain conditions. Specifically, for information convergence tasks such as collaborative learning, the theory implies that online discussion could be superior if the problem of low feedback immediacy is resolved and symbol variety is adequate for the task.

However, the effectiveness of online discussion remains constrained, in its current form, by practical limitations of the enabling technology. For example, limited network accessibility can lead to extended and unpredictable response cycles (low feedback immediacy) resulting in frustration for participants (Hiltz, 1998). Of course, such problems will be diminished as emerging technologies expand the boundaries of feasibility and open up new opportunities for enhanced functionality. To

continue the example, as network accessibility and handheld computing become more pervasive, online discussion platforms will be mobile-enabled, reducing response cycle frustration (Hill, 2003). Other emerging technology advancements, such as pen-based computing, speech recognition and three-dimensional (3-D) interfaces promise further enhancements and it is the purpose of this paper to develop a vision of next generation online discussion that leverages their convergence to yield an immersive, more expressive environment that captures the best of both worlds, online and face-to-face.

Envisioning next generation online discussion surfaces wide-ranging implications. First, it carries implications for the research community by providing a reference point for identifying research issues and priorities along the path toward realization. In addition, it provides a basis for those in the educational community who are invested in the paradigm to project pedagogical needs, impacts and opportunities in advance. The implications are even broader when considering the growing recognition of e-learning as a key knowledge management tool (Wild, Griggs and Downing, 2002) applicable in any knowledge-intensive organization.

The remainder of the paper provides a review of relevant theoretical frameworks as well as technology developments, a conceptualization of next generation online discussion features and capabilities, an outline of research issues and technological challenges, and conclusions and implications.

RELEVANT LITERATURE AND TECHNOLOGY DEVELOPMENTS

A review of relevant literature and technology developments clarifies the motivation and provides a foundation for the suppositions and conjectures to follow. Generally, the foundation is derived from Media Synchronicity Theory (MST) and observation of emerging technology trends in interface capabilities. The research question being addressed is:

> **What is a realistic vision of next generation online discussion that encompasses the most advantageous aspects of face-to-face and distributed, asynchronous communication to achieve a more effective tool for collaborative learning and knowledge management than either group communication mode alone?**

Ultimately the issues surrounding online discussion as a collaborative learning and knowledge management tool arise from the use of this distributed, asynchronous communication medium in conducting what is traditionally a synchronous, face-to-face activity and thus we turn to Media Synchronicity Theory (MST) (Dennis and Valacich, 1999). MST extends Media Richness Theory (Daft and Lengel, 1986) to incorporate synchronicity as a combination of 1) feedback immediacy and 2) parallelism (multiple simultaneous channels) to help explain group dynamic effects. MST distinguishes information conveyance, or the direct exchange of information, from information convergence, the process of reaching shared meaning. MST postulates that conveyance tasks such as brainstorming are best served by low-synchronicity media (low feedback immediacy, high parallelism) because they minimize inter-channel interference. In contrast, convergence tasks are best served by high-synchronicity media because immediate feedback is needed for ideas to build upon each other and because low parallelism maintains focus and minimizes inter-message interference. MST has been supported by empirical studies such as Murthy and Kerr (2003) that found that student teams engaged in idea generation tasks (information conveyance) using low-synchronicity computer-mediated communication (CMC) performed about as well as those meeting face-to-face (high synchronicity). At the same time, those engaged in problem solving (information convergence) using CMC significantly underperformed their face-to-face counterparts, confirming the importance of feedback immediacy and low parallelism for such tasks.

Applying MST to the use of online discussion in collaborative learning yields important implications. Clearly, collaborative learning is best characterized as a convergence activity, given the goal of shared knowledge building and thus, according to MST, is best suited to high-synchronicity media such as face-to-face discussion. However, MST recognizes some advantages to asynchronous groupware such as online discussion. While feedback immediacy and parallelism are characterized as disadvantageously low and high, respectively, two other dimensions of MST are more favorable. Rehearsability, the extent to which one can fine tune the message before sending and reprocessability, the extent to which the messages can be reexamined in context, are characterized as advantageously high for asynchronous groupware. Rehearsability is important, especially for collaborative learning, because the very rapid feedback immediacy of face-to-face interaction can actually be disadvantageous, pre-empting reflection and incurring premature responses (Weick and Meader, 1993). Reprocessability is critical for knowledge management applications to ensure that the knowledge synthesized can be shared and distributed, surviving beyond the original participants and occurrence (Alavi and Leidner, 2001). Ideally then, next generation online discussion would sustain the current advantages of high rehearsability and reprocessability and at the same time solve the feedback immediacy and parallelism issues.

Hill (2003) suggests an immersive, mobile-enabled "third-generation" (3G) threaded discussion conceptualization that addresses these issues. He argues that in leveraging pervasive connectivity and handheld computing, 3G threaded discussion would "better emulate face-to-face discussions by delivering the discourse, in device-scaled form, to the participants in real time wherever they are" using a "push-oriented," Instant Messaging type approach. It can be argued that relieving the

network accessibility constraints and adopting an active messaging orientation might significantly improve feedback immediacy to approach that of synchronous meetings. However, at the same time, by not imposing a 100% immediacy expectation, rehearsability is maintained. Furthermore, the threading paradigm imposes a degree of structure, argued to alleviate the negative effects of high parallelism by ensuring a base level of coordination. (In fact, Dennis and Valacich make a similar point, noting an exception to parallelism problems when using voting structures that integrate individuals' understandings.) This conceptualization appears to combine the best of both asynchronous and synchronous communication modes, at least in the context of collaborative learning (as opposed to decision which might require more formal processes), and yet another aspect of the medium remains to be addressed in a more comprehensive vision – symbol variety.

Dennis and Valacich describe a fifth media characteristic, symbol variety, as the number of ways information can be communicated, or the "height" of the medium, subsuming Daft and Lengel's multiplicity of cues and language variety. They postulate that this factor will only affect performance (negatively) when a needed symbol set is not available and they characterize both face-to-face and asynchronous online groupware as capable of supporting the full range from low to high symbol variety. However, while it is technologically feasible to incorporate high symbol variety, including graphics and full-motion video, into asynchronous discussion, the typical discourse is essentially text-based. Dennis and Valacich suggest that low symbol variety is probably adequate for most conveyance tasks, assuming all parties are communicating cooperatively. But in the context of collaborative learning, at least, this would appear to be a limiting factor since, in the course of developing shared understanding, the kind of subtle misinterpretations to which typed text messages are prone could be inherently obstructive. Furthermore, the potential variety of symbols alone may not fully capture the concept of "expressiveness" that intuitively underlies the ability of the medium to convey intended meaning.

Fortunately, emerging technologies promise to enhance the potential expressiveness level that might be achieved in computer-based communication systems such as online discussion. Microsoft's release of a Windows version for Tablet PC's in 2002 marked a milestone in the development of pen-based computing that signified, finally, that it was ready for primetime or would quickly become so, given the software behemoth's market clout. The integrated "inking" capability enables users to, among other things, "mark up" documents in very natural and expressive ways, exactly as if using a pen on paper but with the associated advantages of digital format. Taking the paradigm to the extreme, Smart Technologies, Inc. (www.smarttech.com) now markets software that enables a pen-based user to mark up live video and overlay audio commentary to produce documents containing layered rich media content. This ability to expressively manipulate high variety symbol sets rather than just attach them to text messages opens up a whole new array of possibilities for next generation online discussion, particularly in the collaborative learning context.

Meanwhile, speech recognition technology is maturing and research efforts such as the DARPA-funded Sphinx program at Carnegie Mellon University are approaching unprecedented levels of performance in continuous, speaker-independent, large-vocabulary applications. Such breakthroughs will enable next generation online discussion to incorporate subtle vocal intonations, etc. to achieve levels of expressiveness approaching those of face-to-face meetings, but with the added benefit of text-based indexing, searching, and manipulation.

Finally, recent advances in simulated three-dimensional computer interfaces carry the potential to visualize and navigate more complicated hyperlink structures than can be feasibly managed today. For example, Sun's Project Looking Glass is an experimental immersive environment said to give users a 360 degree space in which objects can exist in layers, can be pushed farther away, pulled closer, or set aside or even behind (Reid, 2004). Such an interface would allow next generation online discussion to use much richer threading schemes, enhancing expressiveness without overwhelming users' complexity limitations and giving the feeling of being truly immersed in discussion.

Based on MST and relevant advances in enabling technologies, the research question is answered by characterizing next generation online discussion as being an immersive, highly expressive 3-D environment, leveraging pen-based computing and speech recognition and supporting push-oriented, mobile-messaging on handheld devices.

NEXT GENERATION ONLINE DISCUSSION: A CONCEPTUALIZATION AND CHALLENGES

In conceptualizing next generation online discussion, we assume the enhanced-immediacy afforded by active mobile messaging and the mitigation of high parallelism by the threading paradigm, and focus instead on Dennis and Valacich's symbol variety, or more richly, expressiveness, as a key factor to enhanced effectiveness. A number of key factors identify and surface corresponding research issues.

Layered Rich Media

A fundamental paradigm in learning is "show and tell." Hearing an explanation while seeing a reference image pointed to and/or marked up is a powerful method for conveying knowledge that has been a universal standard in education, well suited to our emerging technological abilities to layer rich media. The mass media have introduced millions to the concept in the

form of sports broadcasting which now routinely includes on-the-fly annotation of video replays with drawing and voice over by the announcers. Much of the unprecedented success of the Digital Video Disc (DVD) is attributed to bonus material feature that often includes a running audio commentary layered on top of the original audio/video content. Next generation online discussion will exploit layered rich media capabilities such as those used in the Smart Technologies product described above to realize a highly expressive "show and tell" platform.

Structure and Content

Currently, online discussion is quite limited its ability to convey the structure of a discussion thread. Typically, users can view structure or content but not both at once. However, meaning is embedded in the structure as well and should be easily navigable without losing sight of content or having the structure projected into a single dimensional space as a list of messages in chronological sequence. Necessarily, threading is confined to a simple tree-leaf paradigm that does not allow for clear references to multiple messages or across threads, thereby inhibiting expressiveness.

Next generation online discussion will leverage technology such as Sun's immersive 3-D environment to support more expressive hyperlinking structures while allowing content and structure to be viewed simultaneously.

Granularity

In their current form, online discussions are largely confined to message-level granularity. That is, in the threading structure, a reply message is attached to the message it refers to rather than selected passages from one or more reference messages. Being more specific is possible but unwieldy for the author as well as readers who wish to navigate to the references. Next generation online discussion must facilitate multiple references to specific passages of speech and/or text and/or video.

Reprocessability: Virtual "Live" Discussion

Reprocessability will be enhanced in next generation online discussion by the ability to "replay" the virtual discussion as if it had occurred in real time with the user as an original participant. Thus, after the fact, the immersive, rich media environment can simulate the experience of being engaged in an original real-time discussion that never actually took place. Thus, knowledge is captured and may be disseminated in an engaging form throughout the educational environment or organization.

Usability

Research issues arise in considering usability design questions. Composing layered rich media documents has been and remains today a task for those trained in multimedia authoring, not end-users. Next generation online discussion will need innovative human-computer interface (HCI) breakthroughs to make it easy to compose and edit narrated annotation, especially when it refers to other narrated annotations. Further HCI innovations will be needed to leverage the 3-D interface technology so that users will be able to easily view and navigate complex reference structures while not losing sight of message content and vice-versa.

CONCLUSIONS/IMPLICATIONS

Next generation online discussion promises to elevate effectiveness by leveraging emerging technologies to create an immersive, expressive environment in which there are no limits to symbol variety as well as manipulation. The result may be a tool that surpasses not only current online discussion implementations but also face-to-face discussions as well. The e-learning community will benefit from the ability to address more complex and subtle issues effectively while knowledge management practitioners may find the next generation tool to provide new levels of collaboration and dissemination.

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