Redesigning the Peer Review Process:
A Developmental Theory-in-Action

Abstract

We are looking at how new forms of document interface can be used to support new forms of scholarly discourse, and ultimately, new models of scholarly publishing. Towards this end, we have been using specially designed computer-mediated conferencing technology to realize an innovative peer review model within an academic e-journal – The Journal of Interactive Media in Education. In essence, through re-design of social processes and technical products, we have tried to shift reviewing from a closed process centered on evaluating scholarly work to an open process promoting constructive dialogue between participants. Our experiences indicate that ongoing and explicit mediation activities by editors play an important role in helping review participants (authors, reviewers, guest editors) effectively learn about and participate in the new process. We describe our specific mediation activities and the theoretical framework they are derived from: meta-structuring. The utility of the meta-structuring theory is derived from its explicit acknowledgement that (1) technology adaptation and cultural change are gradual processes that occur primarily after deployment and during use and (2) ongoing proactive interventions (mediations) can facilitate these gradual processes and improve technology use and acceptance. We argue that 'meta-structuring' is an instance of a broader class of theories, which we call "developmental theories-in-action", which offer a promising direction for future research agendas.

Introduction

In our view, one of the biggest challenges in cooperative system design is 'how to get *there* from *here'*. Taking an expanded view of 'system' that includes both technical and social dimensions, 'here' encompasses the current technologies and work practices as well as the pervading 'system of knowledge'; i.e., the cultural and institutional norms that influence practice [6, 18] (Figure 1). Useful techniques and methodologies for understanding 'here' include empirical studies of practice and developing models or theories of the problem domain. It is regarded to be good design practice to take steps to understand the current work context [12].

System design however takes place over 'there', in the envisioned future world of new technologies and new work practices. Again numerous techniques, many from the area of participatory design, have been developed that help both users and designers postulate new technologies and new ways of working with the proposed technologies [13, 26]. Arguably, much computer science research is fundamentally concerned with articulating theories and methodologies of the 'solution domain'; i.e., postulating new technologies and practices within specific application areas (see for example [7]).
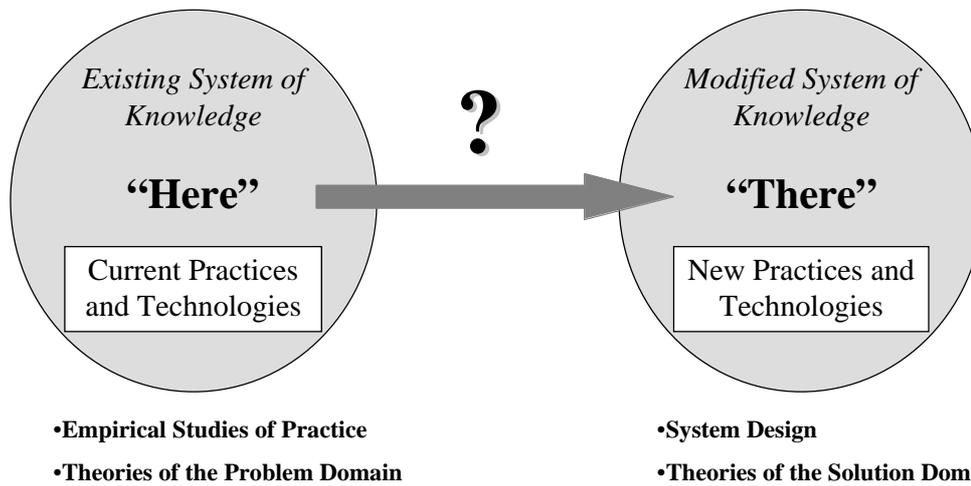
Figure 1: The key challenge for system design is to bridge the gap between current and envisioned use contexts. Theories can help to understand the current problem domain and the envisioned solution domain. Developmental theories-in-action can guide the transition by suggesting proactive interventions in the cultural change process.

However, it is in the transition from here to there where many cooperative systems fail [14]. Sometimes this transition is referred to as a process of 'transfer' or 'adoption', and the challenge for designers is to overcome adoption hurdles [1]. The assumption is that with proper design, hurdles can be minimized and users will more readily take up the system. Implicit in this assumption is the idea that most of the adaptation of the system to the future context of use ('there') occurs at design time. Much research in this area concerns descriptive case studies, often of failures, detailing the adoption problems that arose and how these problems were (or were not) overcome [23]. Grudin has pulled together a number of these studies to generate a set of principles outlining why many cooperative systems fail [14].

Others have argued that viewing this transition as a transfer process is inappropriate; it should instead be viewed as a gradual process of co-adaptation, or even cultural change [21, 24, 27]. The assumption here is that much of the system adaptation takes place after deployment during use. Furthermore, a critical feature of this viewpoint is the acknowledgement of the important role of user adaptation, i.e., changes to practices and systems of knowledge. Again the dominant research model is the descriptive case study. These studies typically focus on success cases, illustrating the gradual adaptation of the system to support new practices and the gradual adaptation of practices to better take advantage of system affordances [20, 22, 28, 32].

While studies such as these provide useful advice and insights, there is very little in the way of proposed theories or models that can be used to systematically guide this critical transition process. Yet, this is exactly where useful theories are sorely needed. As designers, should we be content to create a system and then sit back and see what happens? Or are there steps we can take to proactively support the change process and increase our chance of success?

The purpose of this paper is two-fold. First, we wish to highlight the need for this type of 'developmental theory-in-action'. In our view, such a theory explicitly (1) acknowledges that the gradual processes of co-adaptation and cultural change primarily occur during use and (2) offers guidance on how to proactively support these gradual processes. Such theories are 'developmental' because they target the need for cognitive and social change. They are 'in-action' because they address the need for systematic support and interventions during the change process.

Second, we intend to present and analyze one such theory in the context of a detailed case study. In 1995, Orlikowski et al proposed a theory of 'meta-structuring' that advocates a specific set of technology-use mediation processes aimed at facilitating co-adaptation and cultural change [24]. This theoretical model was derived in part from a case study surrounding the introduction of electronic communication technologies into a particular organization. In the scientific tradition, we have taken this proposed theory and tried to apply it to another setting: redesigning the peer-review process in an electronic journal. To the best of our knowledge, we are the first to take this descriptive theory and use it as a framework to guide future actions.

Towards these dual purposes, we begin the remainder of this paper by describing our research context: the electronic Journal of Interactive Media in Education (JIME). We then present the meta-structuring theory and examine how this theory helped guide our editorial interventions. Finally, we discuss the strength and weaknesses of this theory, and how it can be usefully augmented with models of the problem and solution domain.

Research Context: The Journal of Interactive Media in Education

In 1996, three of this paper's authors (Sumner, Buckingham Shum, and Wright) helped to found a journal targeted at researchers and practitioners in educational media ([17]). Besides being a forum for innovative work, we had two other goals for the journal which we felt could only be realized through electronic publication. First, rather than simply reading about interactive media, we wanted to make it possible for readers to directly experience the systems and techniques being described. Second, we believed that a multidisciplinary field could be best advanced by bringing together people reflecting the field's multiplicity of perspectives. Thus, we wanted to foster discussions between participants from diverse backgrounds (e.g., researchers, educators, system designers, and policy makers) and distant geographic locations. Referring back to Figure 1, our initial efforts concentrated on trying to develop models of 'here' and 'there' with respect to current academic publishing practices and our specific goals. Table 1 summarizes the key points in these two models.

Table 1. Comparing models of the problem domain and the proposed solution domain.

Here: General Model of Current Academic Publishing Practice	There: Proposed Collaborative Reviewing Model
System of knowledge: Reviewing primarily conceived as an evaluative 'vetting' process, to preserve scientific quality and to help prioritize which articles can be included in a finite space resource (paper-based journals) [4, 25, 35]	Modified system of knowledge: Reviewing primarily conceived as a constructive design process where both the underlying scientific principles and methods, and the article itself, are improved through discussion and negotiation.
Predominant practices: monologic commentary by anonymous individuals, all communications mediated by editors, comments are often one-way (from reviewer to editor to author), typically spread out over a long period of time (months), closed process.	Proposed practices: direct dialogue between review participants (reviewers, authors, editors, readers), taking place over shorter time periods (weeks) to speed up reviewing and encourage more 'dynamic' exchanges, open and inspectable review process.
Predominant technology: paper, postal system, email	Proposed technology: world wide web, computer-mediated conferencing, a design emphasizing integrated documents and discourse with simple schemes for structuring discussions, potential for dynamic content including interactive components and hyperlinks

All journals sit within several systems of knowledge, which journals users draw on to assess journal contents and to guide their own practices. One or more systems are typically related to the journal's contents: in our case, the field of educational media. Another system is related to academic journals themselves, which includes shared understandings and norms regarding how journals operate, their basis for authority, the roles of participants such as authors, reviewers, and editors. As shown in Table 1, we were proposing a fundamental shift in the system of knowledge related to academic journals, shifting from a vetting model to a design model. We reconceived the reviewing process in terms of supporting 'design discussions taking place around an artifact' and drew upon prior research into hypertext systems and design rationale [2, 3, 5, 8, 31] to articulate principles for the social and technical dimensions of our design. In late 1996, we launched "The Journal of Interactive Media in Education" with the document-centered discourse interface shown in Figure 2.
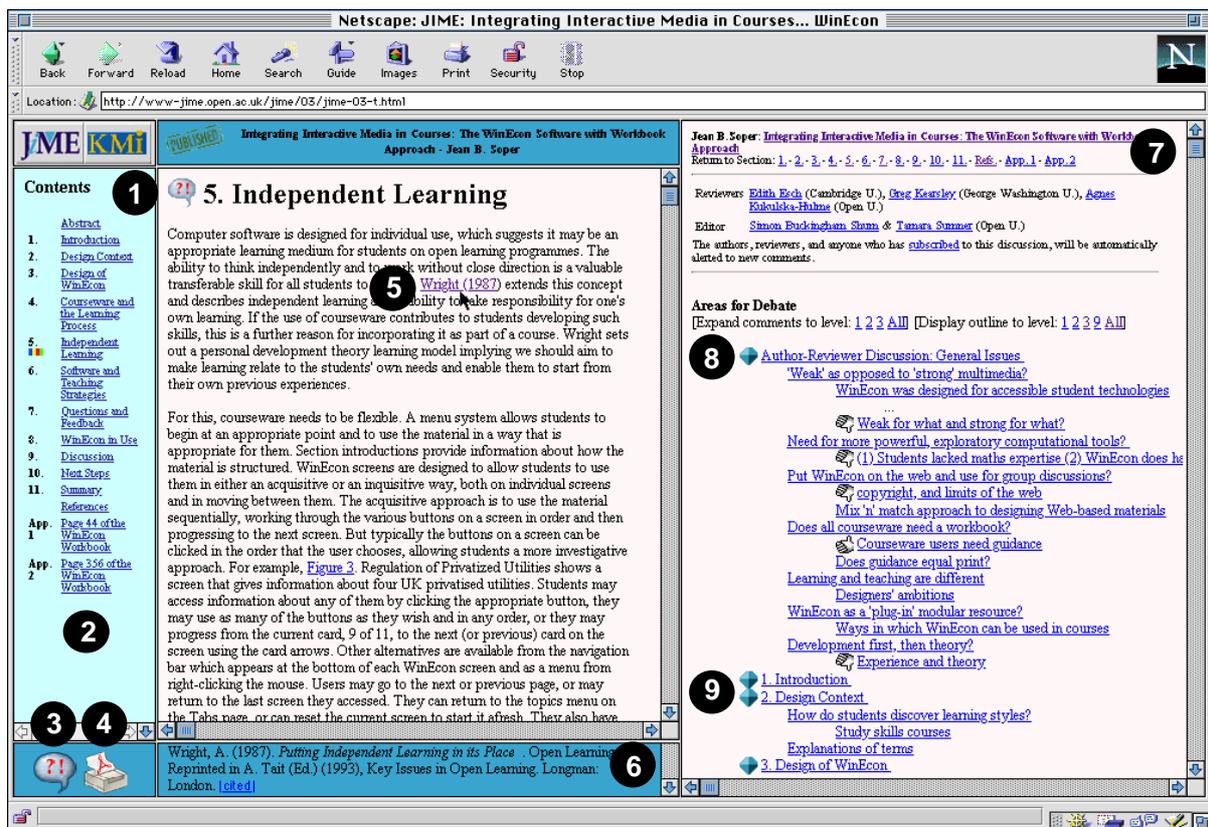

Figure 2: Document-Centered Discourse Interface. On the left is the Article Window, on the right the Commentaries Window showing the outline view of review discussion Key: [1] Comment icon embedded in each section heading displays section-specific comments; [2] active contents list; [3] iconic link to display top level discussion outline; [4] iconic link to download PDF version; [5] citation is automatically linked to entry in references, displayed in footnote window; [6] reverse link to citation(s) in the text; [7] links from discussion back into article; [8] general heading for discussion; [9] headings for section-specific comments.

A key aspect of our technical design is the integration between the document and the discourse, where links to the discourse are embedded directly into the document form itself (e.g., the comment icons at the start of every section heading). Another important design feature is the use of a standardized simple structure for the document discussion area featuring five general review categories (e.g., clarity of results, quality of writing) and specific categories corresponding to major sections in the document itself. As shown in Figure 2, this document-centered discourse interface is very link-rich, making the publication of documents with associated discourse time and effort intensive. To make the publication of these documents tractable, we created a publisher's toolkit to automate large parts of the

mark-up and publication process [30]. The human-computer interface considerations that went into this interface design and the publisher's toolkit are fully described in [29, 30].

A key aspect of our social design entailed rethinking and redesigning the journal peer review process and participant roles to promote multidisciplinary debate (Figure 3). Most of the review process takes place using the document interface in Figure 2, with supplement from email. The discourse (i.e., discussions between readers, authors, reviewers, and editors) is shown in the right pane. When an article is received and judged to be relevant to the journal, the publisher (often the same person as the editor) uses the publisher's toolkit to create a secret review site for that article resulting in the document-centered discourse interface. The editor solicits reviewers (usually three or four) and briefs them on the review process. Next, for a month long 'closed review' period, reviewers and authors discuss and debate the article. While reviewers may choose to remain anonymous, journal policy is to encourage named review and, with only a couple of exceptions, all reviewers to date have done so.
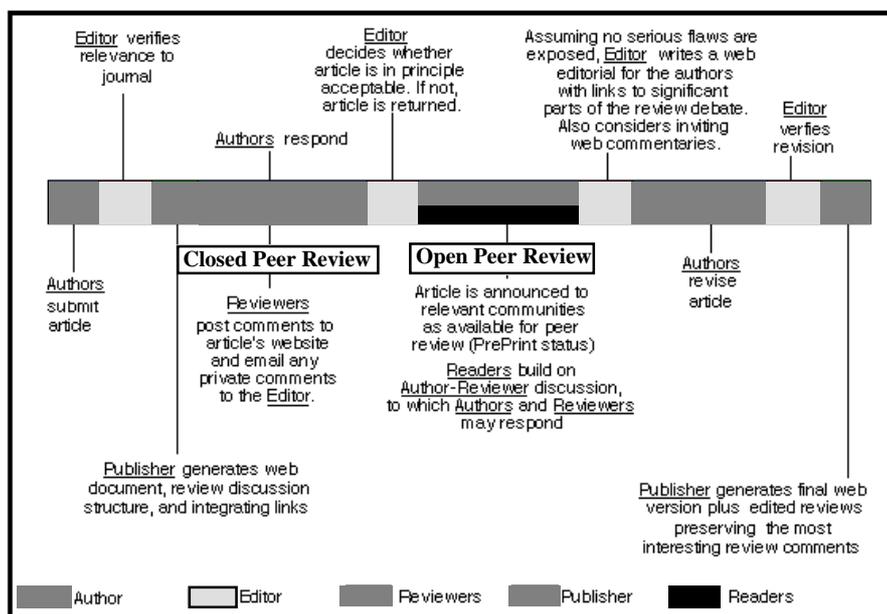

Figure 3: The JIME review lifecycle, showing the closed and open peer review periods, and the active stakeholders at different points.

Based on the outcome of the closed review period, the editor decides whether or not the article is in principle acceptable and should move to the open review period. If so, the secret site containing the submitted article and review debate is made available to the public for a one month open review period. During that period, readers are also able to join the discussion. After the open period, the editor performs a meta-review of the article, summarizing the reviewers' points, adding additional comments, and formulating required and suggested changes to the article. Sometimes, instead of requesting authors to modify part of their article in response to a comment, the editor will instead ask authors to respond in the review debate and suggest linking to this part of the debate in the article itself. Such linking enables authors to use the review discussion as a form of 'amplifying footnote'.

The authors then modify the article in response to the review debate and the editorial meta-review. When the editor receives the final article and judges the modifications to be acceptable, the editor then edits the review debate to determine which parts will be published with the final article. Low-level comments pertaining to writing style or syntax are removed since these should have been addressed in the rewrite. Likewise, comments suggesting how

to change parts of the article that have been addressed are also removed. Essentially, the editor culls the review debate to make sure the context that the comment pertained to still exists. If it doesn't, the comment is removed. Sometimes the editor will ask reviewers if they wish to modify a specific comment or add another one in light of changes in the article. Often the comments left after this culling are those related to broader theoretical or methodological issues, related experiences or systems, ancillary questions, etc.

'Meta-Structuring'-in-action

During the first few months of journal publication our results with this new document interface and peer review process were promising but uneven. Some debates were extremely successful while others fell flat. Despite online instructions and how-to briefings by the editors, we encountered a variety of re-occurring problems amongst participants, including:

- Difficulties stemming from a lack of new media 'literacies'; i.e., authors may not realize how to best present their work in this new medium or reviewers may never have used computer-mediated conferencing (CMC) before.

- Being unsure about the new reviewing process in general, or about their changed role in the process. This was particularly the case with authors, whose roles had changed from passive recipients to active participants.

As editors, we were interested in taking proactive steps to prevent, or at least mitigate, these re-occurring problems and difficulties. The meta-structuring theory proposed by Orlikowski et al offered a potentially useful framework for developing the necessary intervention activities (see [24] more information). This theory builds on prior theories of structuration [6, 11]: when people use technology, they draw on affordances of the technology (Figure 4, arrow 2) and their enculturation into a system a knowledge to guide their use; i.e., knowledge about how peer reviewing usually works (Figure 4, arrow 1). In turn, their actions with the technology can have several effects: either serving to *reinforce* the existing system of knowledge, or to slightly *adjust* or modify the system of knowledge, or to more radically *change* the system (Figure 4, arrow 4). Similarly, their actions can also reinforce, adjust, or change properties and features of the technology itself (Figure 4, arrow 3).
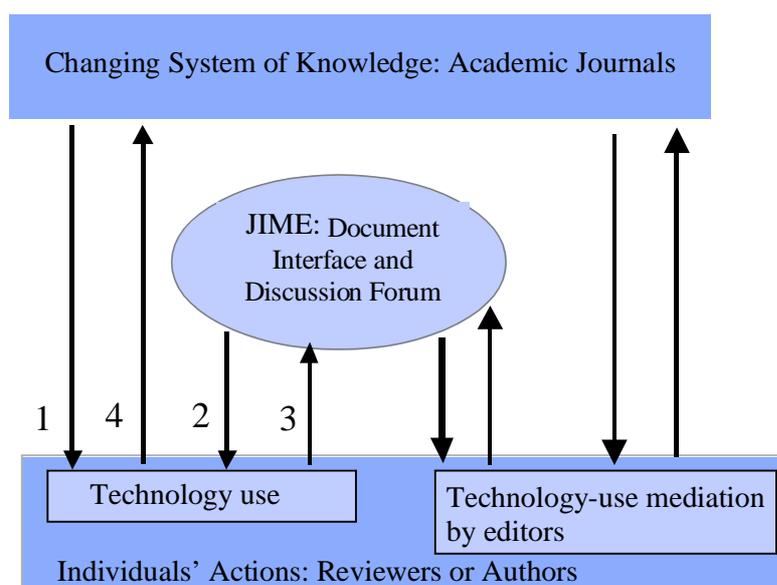

Figure 4. Meta-structuring in the context of JIME (Adapted from Orlikowski et al 1995)

Meta-structuring theory suggests that a few individuals can influence and shape other user's actions and their use of technology through deliberate, explicit, ongoing, and organizationally sanctioned *technology-use mediation* activities. The purpose of these mediation activities are to "structure user's use of technology" by influencing users' actions and interpretations, changing the system of knowledge influencing use, and modifying the technology (Figure 4, all unlabeled arrows) – hence the name 'meta-structuring'. Mediating activities fall into four broad categories, depending upon whether the activity serves to *establish*, *reinforce*, *adjust*, or *change* a new system of knowledge. Specific actions corresponding to each of these categories are listed in the middle column of Table 2. Actions denoted by '+' are those originally proposed by Orlikowski et al; those denoted by '*' are actions we have added or modified based on our experiences publishing JIME. Below we will briefly describe a few specific actions from each of these categories to give readers a flavor of the types of mediation activities we have engaged in.

Establishment actions include designing and installing the new technology (JIME document interface), getting organizational backing for the new technology (from the editorial board), and creating guidelines outlining the envisioned use of the technology (the new peer review model). These types of activities are found in many system design and development projects. Based on our experiences, we believe that developing models of the current problem domain and the envisioned solution domain are also important components in this phase, helping with the design of technology and guidelines for use. The strength of the meta-structuring theory however lies in the recognition that further actions are needed after establishment.

Reinforcement actions should promote new practices and increase users' awareness of and facility with the new technology. In our case, descriptions of the new peer review process were always given to potential reviewers when they were invited to review an article. However, like many software users, not all reviewers carefully read the instructions. Even if reviewers do read the instructions, they may have problems remembering how the new process works (there is usually a delay between when they are invited and when the review period commences). Thus, we reinforce both the collaborative aspect of the reviewing process and shortened review period (one month) using 'welcome' and 'closing' letters. The editor solicits reviewers and when all reviewers (usually three or four) are arranged, the editor uses an email 'welcome' letter to introduce the participants (authors and reviewers) to each other and brief them on the upcoming review process. The closing letter is sent out one week before the end of the review period as a gentle reminder. These letters began as small experimental 'adjustments' and have since been incorporated into our standard editorial practices.

Adjustment actions serve to fine tune the technology to better support practices and vice versa. For instance, analyses of our server logs suggested that users were bookmarking review debates and checking the debates periodically, presumably to see if any new comments had been added. To support keeping track of a debate we added a notification feature. Whenever a new comment is added, all people subscribed to that debate receive the new comments in their email. To help increase their awareness of the flow of the review, all reviewers and authors are automatically subscribed to the article's debate. Subsequently, we have noticed that some reviewers use a 'modified two-pass' review technique: coming online once to make their review comments and then coming online periodically to respond to other's comments as they are posted. To help with adjustments, mechanisms are needed for obtaining feedback from users on an ongoing basis. In the JIME project, we rely on informal observations by editors, feedback from reviewers, and periodic log analyses [34] to help guide our adjustment decisions.

In contrast to adjustments, episodic changes are larger in scope and occur periodically, rather than gradually over time. Episodic changes include major changes to the technology and to the envisioned practices. In JIME, a major change in practice occurred when we decided to conduct the editorial meta-review in the JIME document interface where all participants could see and comment on the editorial review itself. This began as an experimental adjustment and later was officially incorporated into the revised peer review lifecycle. This radical change helped to reinforce the collaborative nature of the review process and it enabled editors to showcase advanced features of the system and CMC good practices in their comments. For instance, we try to encourage the use of comment titles, as these help to make the debate outlines more readable (see right side of Figure 2). Also, as shown in Figure 5, we demonstrate and promote the use of hyperlinks to make explicit the relationships between: (1) the article and its associated review debate and (2) other articles in JIME.
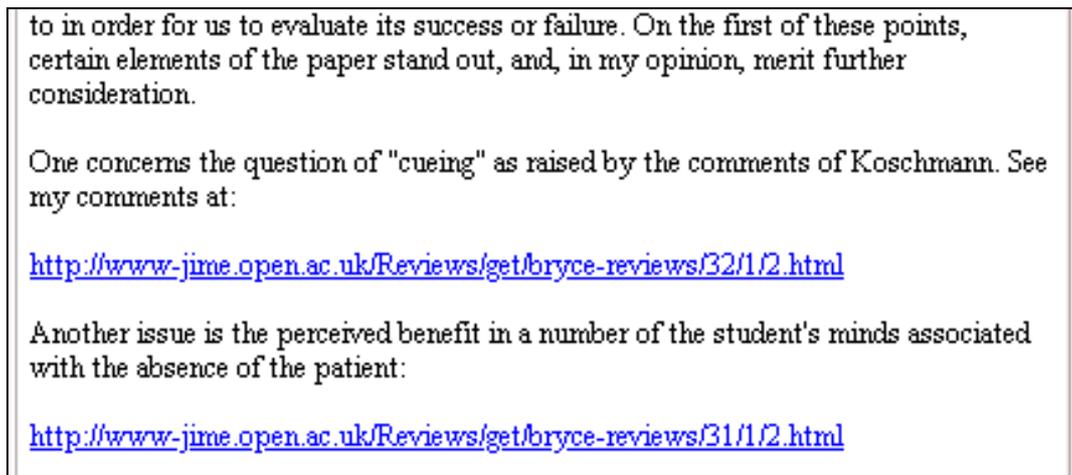

Figure 5: Editorial demonstrations of 'threaded hypertext literacy'—contributions to online peer review debates with citation and cross-linking from one review discussion to another.

Table 2. Description and examples of technology-use mediation activities

Mediating Activity Categories	Actions (+ original, * new or modified)	Examples from JIME
Establishment	*Analyze current and envisioned 'systems of knowledge' that guide practice and technology use.	Examined existing peer review and publishing practices; i.e.,,problem domain. Explicitly formulated vision and goals for new publishing and peer review practices; i.e., solution domain.
	+Set up physical parameters and features of the technology.	Used explicit model of solution domain to design JIME document interface with integrated discussion forum and installed it on server.
	+Modify institutional properties of the organization to facilitate technology assimilation.	Persuaded founding editorial board to sanction the new system as the official medium for publication.
	+Articulate the cognitive and behavioral routines through which the technology may be appropriated by users.	Used explicit model of solution domain to define the new peer review model and articulated the roles of participants in the review process.
Reinforcement	+Maintain the operational fidelity of the technology.	Maintain the JIME server; e.g. registering new participants, software upgrades, bug fixes

	+Help users adopt and use appropriate cognitive and behavioral routines to use the technology.	Educate participants by: (1) providing a description of the review process when inviting them to participate; (2) reinforce the collaborative aspect with a 'welcome' letter to kick-off the review process introducing participants; (3) reinforce the short time period by sending out a 'closing' reminder one week before the end of the period. Demonstrate use of advanced features (e.g., hyperlinks) and CMC good practice (e.g.., comment titles) in editorial meta-review comments. Provide advice to authors about how to best present their work using hypermedia and interactive components.
Adjustment	*Monitor use to detect re-occurring patterns and common problems	Observe debates and periodically analyze server log files.
	*Use models of problem and solution domains to help identify and understand potential problems.	Biggest proposed changes in the review process are the change in the author's role and the faster pace of review. We need to increase participants' awareness of these changes.
	+Adjust technical features of the technology to promote use.	Add notification feature. Add accounts (logins and passwords) for reviewers as a shortcut to entering personal information.
	+Alter usage rules and procedures to facilitate the use of the technology and to promote new practices.	Prior to review, create accounts and subscribe reviewers to notification feature. During review, remind authors they are not only able to, but are encouraged to participate. After review, acknowledge review participants on front page of journal.
Episodic Change	*Periodically conduct formal analyses of technology use and facility with new practices.	Systematically analyze debates, editorial mediations, and publishing lifecycle.
	+Redesign the technical functions and features of the technology	Added 'JIME Announce' forum to keep community abreast of developments and new publications. Making review participating more visible by including reviewing information in the search engine; i.e., you can search on reviewers.
	+Modify institutional properties of the organization to facilitate change in technology use.	Modified editorial practices to use document interface for editorial meta-review comments. Explicitly adopted goal to use editorial comments to illustrate advanced features and good CMC practice.
	+Redefine cognitive and behavioral routines to facilitate change in users' appropriation of the technology.	Modify proposed review lifecycle to reflect changes in editorial meta-review practice. Formalize 'welcome' and 'closing' letters into editorial practice.

Discussion: Are Technology-Use Mediation Activities Useful?

Here we will discuss the value of technology-use mediation activities from several perspectives. First, we examine their effectiveness towards facilitating the use of the JIME document interface and the new peer review model. Second, we discuss their value as a teaching tool when bringing new editors on board. Third, we consider the overall value of the meta-structuring theory as a unifying framework for guiding design and deployment actions and discuss our modifications to the activities originally proposed by Orlikowski, et al

Use of Document Interface and Uptake of New Peer Review Model

Since the launch of JIME we have been archiving all the review debates for both accepted and rejected articles. These archives contain the full debate, resulting from both the closed and open review periods, and before the debate is edited for article publication. We are currently conducting a detailed quantitative and qualitative analysis of these debate archives (19 articles total). While a complete description of these analyses is beyond the scope of this paper, we will use some of our preliminary findings to consider the effectiveness of our mediation activities.

Let's first consider participation in the overall process. During the review of these 19 articles, 45 out of 46 reviewers (many have reviewed more than one article) completed their reviews during the closed review period. While this is ostensibly their job and what they agreed to do, this level of reliable and timely reviewer participation is quite rare in any review process. When we initially proposed this model, a common critique was that it would prove difficult to find reviewers that were willing and able to conform to this rapid timetable. This has not been the case. Furthermore, authors have participated in all 19 of the review debates, though the amount of author participation has varied considerably. We regard these measures as indicators of some success.

Examination of the review comments suggests that, with a few exceptions, the overall tone and content of the reviews are collegial and collaborative in the sense that reviewers are explicitly relating their comments to those made by other reviewers. In some debates, as much as 50% of the comments explicitly refer to or build upon another participant's comment. These can take many forms, such as referring to a commentator directly in the text of a comment; e.g., "I agree with Henry that…" or "I think you are right but…". Or alternatively, participants refer to a comment using technical features of the medium; e.g., using thumbs up or thumbs down comment categories to agree or disagree with a previous comment, or physically including parts of a previous comment within a response. Again, we regard these findings as indicators of some success, especially in light of prior research which attributes the high rejection rate in 'soft science' journals, especially multidisciplinary journals such as ours, to a lack of agreement about what constitutes 'good science' amongst reviewers [4, 16, 25, 35]. Indeed, in the best of cases, the debates reveal negotiations between participants about the meaning of important concepts; e.g. "weak versus strong multimedia" or the definition of "narrative". As suggested by Kuhn, when scientific communities do not share a common research paradigm such negotiations about fundamental concepts are the first step towards establishing a shared background [19].

While we are reassured that the overall process is basically working, preliminary analyses suggests that there is still plenty of room for improvement. One of our goals was to foster dialogue between multidisciplinary participants. Our analyses suggest that this is not happening as much as we hoped for. While the participants are building on each other's

comments, they are mostly *talking about* each other ("I agree with Henry that…") rather than *talking with* each other ("I think you are right but…"). There are indications that this may be related to the asynchronous nature of the medium and the sparse days of active participation in the review process. During the closed review period, participants are typically active about 15% of those days. With three or four reviewers and a month-long review period, this sparse rate of participation is probably to be expected. When participants are talking with each other, these comments tend to be clustered together in time (e.g., same day or successive days). When participants are talking about each other, there are often days or even weeks between comment postings.

This difference in behavior may be linked to the different reviewing strategies adopted by reviewers. Some reviewers come online for one day and make all their comments at once, adding their own insights and responding to existing comments (a one-pass review method). Other reviewers adopt a 'two-pass method': they come online once and add their insights and then come online another day and respond to other's comments. A few reviewers use a 'modified two-pass' method: they come online once and add their comments and then monitor the debate and come online periodically to respond to comments as they are made. Clearly the opportunity for dialogue is limited when reviewers use the one-pass reviewing strategy. As a next step, we will consider how to adjust our mediation actions to promote the use of two-pass types of reviewing strategies.

It would be very difficult, perhaps impossible, to unambiguously prove that our technology-use mediation activities were the cause of our success to date. For instance, we have noticed a general increase in 'comfort level' with the World Wide Web and CMC technologies amongst participants over the last two years, which surely helps our chances. Also, while we believe our technical system to be thoughtfully designed and well conceived, it cannot be credited with 'causing' our success to date. We have used this same technical system in other application areas (including other e-journals) with widely varying degrees of success [30]. Our experiences with these cases suggests that having an explicit model of the desired participation structure (i.e., the JIME peer review model) and a battery of mediation activities to reinforce and promote the new participation structure are extremely important components in the overall process.

Bringing Other Editors on Board

As with most academic journals, we have a large and distributed editorial board, with members in the Americas, Europe, Asia, and Australia. To increase editorial involvement and keep the workload of the founding editors manageable, we are trying to use a distributed editorial model, with different editors taking responsibility for different journal submissions. This has proved to be quite challenging!

Similarly to other participants, most potential editors have considerable experience in traditional journal reviewing practices and their mental models of editorial activities are based on these prior experiences. At first blush, when examining the idealized JIME peer review process (Figure 3), it appears that the editor is not deeply involved in the process until the end when he or she performs the editorial meta-review. Our first few guest editors were relying heavily on this idealized model of editorial involvement and met with disappointing review participation results; e.g., not much discussion or low author participation. In one case, we (the founding editors) had to take over the review process when it completely faltered. By looking at our own actions through the theoretical lens of the meta-structuring theory, we have realized how critical the editorial mediation activities are. The meta-structuring theoretical framework has proved to be a useful tool for thinking about and

making explicit the activities of editors in this new peer review model. As such, having an explicit model of editorial mediations has helped us to coach new editors on their roles in JIME peer review process. While there is not enough data to draw specific conclusions, recent experiences of guest editors show considerable improvement in the overall participation in the review debates.

A Useful Unifying Framework

Meta-structuring theory provided a useful framework for integrating many of our design, development, and ongoing support activities. It helped us to be explicit about our overall process and interactions with 'users' and in turn, this explicitness aided our teaching and coaching of guest editors. We did however, make some adjustments to the original framework. First, Orlikowski et al developed this framework in the context of organizational research, specifically looking at the relationships between technology use and changing institutional properties. Here, we refer to 'systems of knowledge' rather than 'institutional properties of the organization' to connote a broader shared understanding of material and social practices amongst members of a professional community that span many organizations. Second, we have modified the proposed mediation actions (Table 2) to indicate where 'traditional' design and development concerns fit in to this framework. These modifications included specifying where feedback is needed to formulate mediation actions, and where problem and solution domain models can augment the process. These additions help move the framework from the realm of descriptive theory towards advocating a course of action.

In our view, meta-structuring is an instance of a broader class of theories which we call 'developmental theories-in-action'. Such theories can be helpful to the design and deployment of cooperative systems because they explicitly acknowledge (1) technology adaptation and cultural change are gradual processes that occur primarily after deployment and during use and (2) ongoing proactive interventions (mediations) can facilitate these gradual processes and improve technology use and acceptance. The 'continuing education' perspective advocated by this class of theory is perhaps particularly beneficial when the technologies are open-ended (i.e., they afford many styles of use, unlike systems such as the Coordinator [33]) and when use is discretionary [15].

While meta-structuring is an iterative process, it differs from iterative design and rapid prototyping in its emphasis on supporting adaptation after deployment, rather than in the design phase. Recently, iterative design approaches have been extended to include post-deployment social processes [22], but these intervention efforts are generally not guided by a uniform theoretical framework. In a similar vein, Fischer et al have postulated an extended software system lifecycle model based on the phases of seeding (design and implementation), evolutionary growth (adaptation during use), and reseeding (redesign and restructuring) [10]. While this theory incorporates an extended system lifecycle and helps to guide interactions between users and developers, it does not address the critical area of enculturation; i.e., helping users to gradually adjust their practices and systems of knowledge. Perhaps the theory most closely related is that of 'domain construction' [9, 27]. Domain construction considers how technology can support the practices of professional designers as they collaboratively construct their design vocabulary, representations, and practices over time. This theory differs from meta-structuring in that it does not expressly consider the role of external mediators in the overall process.

Summary

We have described our experiences using specially designed computer-meditated conferencing technology to realize an innovative peer review model within an academic e-journal – The Journal of Interactive Media in Education. Through the re-design of social processes and technical products, we have tried to shift reviewing from a closed process centered on evaluating scholarly work to an open process promoting constructive dialogue between participants. Analysis of our review archives suggests that we have made important steps towards realizing this goal: review debates appear to be collaborative but not necessarily dialogic. Our next step will be to consider how editorial meditation activities could help promote reviewing strategies more conducive to dialogue.

At a different level, we have discussed how our actions were guided by a particular theoretical framework based on the notion of meta-structuring. We have tried to argue that developmental theories such as this one can be useful tools guiding the design, deployment, and ongoing support of cooperative systems. However, such theories and descriptions of their use in real projects are rare, and as such, indicate a promising area for future research.

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