Meta-Communication Widgets for Knowledge Building in Distance Education

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Abstract: "Knowledge Building" is a theory of learning, which emphasizes the collaborative construction of knowledge by a group of learners. Students develop their understanding through sustained inquiry that pursues collective goals of understanding; it is driven by student questions and explanations, in self-directed small groups. Although it can be practiced without computer support, computer software such as Knowledge Forum™ is designed to support such collaborative learning. "Widgets" are software user interface elements that display information and allow the user to manipulate the information display or to accomplish some task. This paper suggests specific classes of widgets that might help learners better attain knowledge building objectives, by distinguishing between the substance of knowledge building and the "meta-communication" which surrounds its development. Widgets designed according to knowledge building principles may help facilitate and articulate this meta-communication component of knowledge building. This is particularly so in distance learning, where the meta-communication usually cannot occur outside the system, as it could in a face to face environment.

Keywords: knowledge building, widgets, meta-communication, object-oriented design

Introduction

Current Web documents often feature small embedded forms that allow users to do something – provide feedback, purchase something, rate an article, search a search engine – all in the context of the content of the Web page. This paper proposes that this kind of interaction may be a useful extension of knowledge building learning environments. Further, we attempt to make explicit the learning principles underlying our design (Koschmann, in press), by examining the principles of knowledge building and then proposing user interface elements ("widgets") which are consistent with that design.

The goal is to separate and enhance the "meta-communication" between learners when they are talking *about* the learning process, as distinguished from their articulation of the "substantive" learning, itself. The hope is to increase the focus on the substantive knowledge and understanding being developed, by providing a separate channel for the support communication, and to do it in an easy, focussed, and context-aware manner. This may be particularly useful when the opportunity for face-to-face meta-communication is missing, as in much distance learning.

Additionally, the "widgets" are computational entities, which can enhance the communication beyond the simple transmission of textual content. They can serve as agents, performing notification, reminding, calendar management, prioritization, agenda management, referral, and other processes consistent with enhanced knowledge building.

Knowledge Building Systems and Principles

"Knowledge Building" systems, such as Knowledge Forum™ (Learning in Motion, 1998), are networked computer software systems designed to help a community of learners develop their knowledge through sustained collaborative pursuit of collective goals of understanding. Learners do this by contributing to a communal database which reflects the knowledge of the group members and which is an intellectual object open to collective scrutiny and elaboration by the group of learners.

Knowledge Building, as a concept and practice (Scardamalia and Bereiter, 1991, 1994, 1996), can be characterized by these principles:

- Knowledge Building is an activity of the whole learning community.
- It involves sustained, in depth inquiry, focusing on specific problems.
- Inquiry is self-directed, usually in small groups, and driven by student questions.
- There are collective goals of understanding .
- Discourse is taken seriously, and it focuses on explaining and articulating individual understanding.
- Articulation of individual understanding is publicly available to the group.
- Continual improvement of ideas is achieved by revisiting them for collaborative, iterative refinement.
- The teacher is a facilitator, an expert learner, and not the source of all knowledge.

Although Knowledge Building could be practiced in ordinary classrooms without special computer assistance, it is best supported by networked computer software which supports these principles. For instance, Knowledge Forum serves as the communal database where student inquiry takes place and their ideas are articulated and refined. Such software provides knowledge building affordances that encourage and manage the development of understanding.

Human interaction is particularly crucial to knowledge building. When knowledge building software is used in the face to face classroom, students and teacher interact directly to manage the learning experience. Much of that interaction is communication about the ***process*** of knowledge building: how to do research, tips about what to explore next, who to get help from, how to plan, which sub-goals might be more productive, who is working on similar aspects of the problem, suggestions of ideas to revisit or recast, deadlines, work plans, timelines, and many more aspects of getting the job done. Much of this communication has little substantive content, but is crucial because it serves to organize and facilitate the knowledge building process.

However, in distance education environments based on computer conferencing or email, all communication flows through the same medium, where substantive and other types of communication are intermixed. As a result, the substantive knowledge production is often diluted by the other communication activity.

In this paper, we advocate the separation of communication in knowledge building environments into two streams, depending on whether it is substantive or not. The latter is the "meta-communication" of the knowledge building process. By "meta-communication" we mean all communication between the members of the learning community, which is not communication of the substantive understanding itself.

We propose that separating the meta-communication from the substantive communication may be useful in two ways. 1) In the design of collaborative learning systems, the separation may offer a design perspective that is more faithful to the principles of knowledge building. 2) In actual collaborative software, the separation can provide learners the affordances which help make evident and reinforce good knowledge building practices.

Thus, the aim is to provide a more effective means of communication of the substantive understanding by separating out the various communication acts that are not substantive. The non-substantive communication may be central to developing the substantive understanding, such as planning, management, evaluation and team building, or it may be incidental, such as general encouragement and group chit-chat, but it may be usefully separated from the substance of the learning.

Some knowledge building software does attempt such separation, although the facilities may be limited. For instance, in the Collaboratory Notebook of CoVis (O'Neill and Gomez, 1994), students provide substantive information by creating "notebook pages", while each page distinguished by its "type" (question, conjecture, plan). These in turn, automatically communicate the intent of the page, and thereby imply or control the types of information that other students can provide in response. O'Neill and Gomez suggest that this mechanism would further the students' research strategy, with more emphasis "directly on facilitating a learning dialog between collaborators than on an individual's thinking." (p. 419) The "type" of page designation applies to the whole page and is external to it, whereas the widgets envisioned here will be within a page and context-aware.

In Knowledge Forum, students are encouraged to articulate their understandings in the notes they write in the database, and to use "scaffolds" and "supports" to perform a meta-communication function. These serve a dual purpose of helping organize the writer's expression of their thoughts and the process of their development, and also communicating to others the intent of the information in the note.

For instance, a standard scaffold oriented to theory building has:

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Theory Building
         My theory
         I need to understand
         New information
         This theory cannot explain
         A better theory
         Putting our knowledge together
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These scaffolds and supports serve an implied meta-communication function in some cases, particularly when the relationship of the scaffold user to the original author of the base idea is taken into consideration. For instance, a build-on note that gives "New information" in response to a note which has an "I need to understand" support, has shown implied meta-communication between the two notes' authors.

In Knowledge Forum, these supports can be inserted into the note text at any point and thereby mark the subsection of a note and represent a particular category or intent of that portion of the note. Thus, a scaffold can serve as a writer's compositional aid, an explicit part of the articulation of an idea, an implicit request to the reader, or perhaps some other meta-communication purpose.

Multiple Knowledge Forum supports may be used anywhere in a note, to communicate something about the process of knowledge building or – implicitly – to solicit an action by other learners. Thus, they serve meta-communicative purposes, even to oneself, but are limited to human interpretation of the textual notation.

Knowledge Building Widgets

We propose a class of meta-communicative entities that are modeled on the use of scaffolds, but which provide much more capability because they go beyond textual labeling to harness the computing capabilities underlying a computer based knowledge building system.

We use the term "widgets" for these entities. In the human-computer interaction literature, "widgets" are software interface elements which display information to the user and (often) allow the user to manipulate the interface either to alter information display or to accomplish some task. Examples include windows, scroll bars, menus and buttons. Widgets have been used in real-time educational groupware to provide awareness of the presence and activities of other learners (Gutwin, Stark and Greenberg., 1995).

Widgets are usually provided in the user interface as built-in software features, separate from the document content. However, here we extend the idea to provide entities that the user can insert into the substantive document (note) and which then effectively become part of a specialized user interface, specific to that note. These widgets, like the scaffolds in Knowledge Forum, may appear anywhere in a note and by their placement, imply a connection to the note content with which they are associated. They could appear as a small icon with a distinctive design to indicate the widget's function, much like the annotation icons in some word processors.

Moreover, it is important to note that these widgets would initiate and control a computer-based process. These widgets can be thought of as agents, containing information and carrying out activities to advance the knowledge building process for the individual and the learning community. We will discuss widget agency below. Additionally, the widgets can, together, represent knowledge building facilities that surpass the impact of any one of them, through their cumulative ability to record, notify, summarize, and – perhaps – work together.

The idea and practice of adding such widgets within documents is now commonplace on Web pages, where icons and forms can be included at any point. When activated, they cause some effect, such as allowing the reader to email the author, provide evaluative feedback, purchase a product, define a term, etc. Although this use is commonplace on the Web, the point here is to suggest a principled set of knowledge building widgets for use in the distance education environment, and demonstrate how the associated computer-based process can serve those knowledge-building principles.

The widgets proposed here also seem to implement aspects of elaborate hypertext systems (Nelson, 1999; Berners-Lee, 1999), although our emphasis is less on connection to other documents, and more on the processing power of the computer and the knowledge building

theory base of the present task. Also, our widgets' behavior and the idea of widgets as agents are reminiscent of the types of agents that can be created in a MOO or the methods and general characteristics of objects in the Object Oriented programming paradigm (Fowler, 1997).

Goals of meta-communication in Knowledge Building

Widgets should embody Knowledge Building principles. One of the prime ideas of knowledge building is that student understanding and ideas are articulated and progressively refined by the interaction of the community of learners. For this to occur, ideas need to be revisited frequently by many different members of the community, for purposes of refinement and elaboration. Members of the community need to take on this task on a frequent and continual basis; the software affordances should encourage and support this revisitation, iteration and refinement of ideas. Knowledge building widgets should encourage these behaviors.

Knowledge Building is a group collaborative activity of learners, contributing "value-added" to each other's learning. The importance of high quality learner cognitive involvement is crucial. For instance, higher cognitive operations (describing, analyzing, and synthesizing) are more useful in knowledge building than are simple mechanical and rote operations (copying, telling). Thus, when a fellow learner suggests a resource and gives their assessment of it, it is more valuable in this context than the output of a Web search engine. Learners providing support for an assertion is more important than the assertion itself. Widgets might help gather and organize that support.

We propose meta-communication widgets which facilitate and support human behaviors that contribute to knowledge building. We envision widgets which, once installed in a note, will automatically interact with other learners, external databases and data sources, and communication systems. But the overall goal is to support communication between learners, communication that increases their knowledge building effectiveness by focusing on the task, revisiting ideas, encouraging collaborative involvement, and making explicit effective knowledge building strategies and activities.

These widgets should offer principled but "low cost" ways to participate in knowledge building. The meta-communication should be explicit, often simple and stylized, consisting of selecting an appropriate widget from a palette and inserting it into the substantive note at the appropriate place. Some widgets can ask for additional information, through the use of pull-down menu, radio-button or text box components. Other students who come across a widget already placed in the substantive note can click on it and interact with the resulting display of information or information input elements. Thus the "cost" or effort of contributing in this way is much less than having to create a whole note. While it is expected that all members will make substantive contributions, the meta-communication widgets may encourage those who might otherwise be inclined to "lurk" to enter the active knowledge building process, and thus broaden participation.

Agency of Knowledge Building Widgets

The proposed widgets are computationally active annotations on the substantive content of the ideas being developed by the individual and the learning community. They can harness the computer and network power in a number of useful ways:

- Alert colleague learners and/or the teacher/facilitator, bringing to their attention the note, a portion of it, an assertion, a place where they could contribute.
- Provide feedback or evaluation, show one's presence in a note.
- Solicit feedback, agreement, prioritization, and organization.
- Plan, sequence, optimize, remind.
- Display alternatives: histories, expression, approach.
- Associate instances, counterexamples, data sources and evidence, including normal academic citations, but also active searching mechanisms within and outside of the current database.
- Motivate by comment, data, temporal considerations, or external events.
- Summarize and track the knowledge building activity.
- Provide an attention-directing facility by producing an individual "update page," summarizing what's new.

All of these can be initiated by the note author or by a reader, but use computation and the involvement and action of other learners to accomplish their ends.

Example Knowledge Building Widgets

The following is a list of possible examples, illustrating classes of Knowledge Building Widgets and suggesting how they might harness computer power and other learners' activities to achieve knowledge building principles.

Scaffolds: Scaffolds and supports are already features of Knowledge Forum, though they are currently inert text which is valuable only if discovered (or found in a search) and used by a human learner. Marrying the current concept with computing potential suggests that there may be a class of scaffold or support widgets that could perform ancillary services. For instance, an "I need to understand" scaffold might issue a request for help to a colleague or mentor, or record the need on a common list of pending issues. Such a scaffold could also automatically record suggestions made by visitors (or, more pessimistically, record the transient presence of visitors with nothing to offer to meet this need).

Comments: These annotations on the substantive text can be of several types, from a range of sources and serve many purposes. Although basically textual, the computing capability of widgets makes additional functionality possible. At a minimum, a comment widget could provide feedback to the commentor that the note author has seen or reacted to the comment. This could be in the form of explicit alerts or silent logs of one's effect on the learning process. Class-wide logs could also be kept and used appropriately to guide the knowledge building and for formative and summative assessment.

There might be several variants of comment widgets, each contributing to knowledge building:

Elaborative comments might include extensions of the target ideas for possible inclusion, or indication of the intent (or exclusion of other interpretations)

Evaluative comments could come from the teacher or from learning colleagues. An appropriate set of widgets could make evaluative feedback more specific by pinpointing the instance within the note that prompted the evaluation. Widgets could automatically participate in the preparation of an evaluation portfolio, by recording the evaluator's comments and explicit characteristics of the target substantive text. The evaluations of the widget could be structured, scaled, or rubric-based, possibly automatically adjusting to the structure, scale, or rubric that is appropriate to the target item.

Feedback comments can close the loop and provide a structured way to provide comment (by author and/or third parties) about the feedback, itself. In a knowledge building community, such comment has its own knowledge building value.

Suggestion solicitation: This is perhaps a more focused version of "I need to understand" scaffolding, but is a generic way of enlisting help from the knowledge building community. It would require the author to specify what sorts of suggestions are solicited. The widget then sits in the document, and may be used by anyone who reads the note. Each suggestion is accumulated, and the author is notified of the suggestions according to some specified criteria. When the author uses a suggestion, the suggestor might get some sort of credit or reward, or at least, notification. The processes associated with this widget should encourage revisiting notes, weighing colleagues' ideas, revision, and community involvement.

Suggestion: The suggestion widget, on the other hand, can be used spontaneously by a reader. Its processes also include notification of the note author as appropriate, as well as possible feedback and/or reward to the suggestor.

Brainstorming: The suggestion class of widgets might also be structured to encourage and organize idea generation.

Coaching: A coaching widget would provide stylized and distinguished way to offer advice on knowledge building processes. Although other widgets could be used for this purpose, the coaching widget might have special facilities such as templates for making coaching suggestions politely (which would be recognized as having a coaching intent), standard sorts of ground-rule reminders that could be sent, and lists of desirable behaviors that should be encouraged. Inserted into a note by a reader or the teacher, they would automatically indicate the content to which they applied. The widget could have logging capabilities to be used appropriately as part of formative and summative evaluation.

Knowledge building significance: This widget could be used to indicate the author's own assessment of how a particular note item holds special significance for collaborative knowledge building. While it could be used to convey one's best knowledge building examples to the teacher (say, for evaluation, because that is a course requirement), it could also be used for its own value in understanding and encouraging knowledge building practices. The widget could contribute to a common list of candidates for "knowledge building act of the week" or for review or presentation (e.g., at an open house) or perhaps serve as a measure or catalog of the knowledge building achievements of the learning community. It could automatically contribute to the learner's ongoing portfolio and would aid reflection on knowledge building that has been accomplished.

Resource: This can serve in the manner of the current bibliographic citations, or it can be a suggestion of a resource. It behaves like a suggestion in the latter case. It also is an active process, allowing direct hyperlink access to the resource (when possible), creating a community wide list of resources (including the context in which used/suggested and who used/suggested it and when). The list should be useful for further knowledge building, cross-note reference and referral, and evaluation purposes.

Vote, rating or tally: Some aspects of knowledge building may be matters of preference or opinion. A vote widget solicits and manages the voting process for a question specified by the author. It could publicize the vote, say on a central list of voting opportunities, with direct reference to the context of the vote (possibly requiring access to the original note). A rating widget similarly displays colleagues' responses. Either widget should encourage revisiting notes. The widget would record the votes or ratings and display them in the note context when appropriate. It could also impose limits, such as one vote per member, time limits, prerequisites for voting (e.g., having accessed some other resource); it could also notify the author or voters of the results when the voting is over. The opportunity to vote and the results could be automatic inputs to the content of the individually generated daily update page.

Quiz or challenge: A widget might allow a note author to challenge readers to take a quiz or other challenge which would require them to test or articulate their knowledge of a particular point. This widget might be uniquely useful in two ways: 1) the challenge or quiz could be motivating, both to the author and to the reader, and 2) the offered answers may indicate misconceptions, alternative interpretations, poorly articulated ideas, etc. A challenge might require that the reader find other notes with related ideas, and the widget might keep both a score and a record of the offered ideas, the latter to be used for further knowledge building by bringing strands of ideas together and showing their relationships.

List of instances: This could start out being a clarification of examples that the author intends in a generalized assertion, but it could develop into a community-developed list of exemplars and counter-exemplars. Again, the widget manages collection, organization, notification and display of these instances.

Referrals to others: This widget can serve as an alert agent, possibly suggesting other community members who should be notified of something (the "somethings" might already be covered elsewhere in this list). Referrals may be by the author or by any reader, to a third party, as in "Chris should comment on this assertion". Again collection, notification, credit, and follow-up can be handled automatically.

Elaboration: This widget would manage the plans for elaborating an idea: goals, conditions, responsibilities, ... (obviously, such a widget would be useful here).

Work list, Responsibility list: Widgets could manage what needs to be done and who is going to do it. A wide range of functionality is possible here, including notification, management of the work and deadlines, inclusion on the participants' to do list, giving credit, and entries in the evaluation trail.

Goals and milestones: This is a planning tool. One would use the widget to state the goal and how it will be reached; the steps might be distributed to individual to-do lists and the deadlines

managed automatically. Readers would have the ability to post potential alternative goals or steps.

Timeline: A timeline widget might be an organizational tool (see Goal and milestones) or a factual statement that would automatically integrate onto a community timeline, and allow for notification of discrepancies and possibly interesting coincident events.

History: Here one could find out what has happened with this note or this idea, including not just its content, but who's interacted with it and how; it could also manage accountability for changes made. Agent actions could also be detailed or summarized here.

Deadline: This time management widget can also contribute to a common list of deadlines, possibly managing their priority.

Checklist: A widget could manage a list of requisite events or components and automatically participate in an alert system.

To-do: A simple widget for noting things to do, it automatically integrates itself onto the individual's (and perhaps others') to-do list.

Prerequisite manager, follow-up manager: This agent notes that follow-up is required and looks after orchestrating it.

Data (base) access: Such a widget supplies or manages data. It could connect to external databases or sources of data, for whatever purpose (e.g., to provide timely instances related to the knowledge building substance).

Behavioral Characteristics of Widgets

The proposed widgets manage active software processes and agents. They contain information and have behavior with the following characteristics:

- They exist in a specific place and scope within a note. Thus, they refer to a specific segment of text or drawing. They know what they refer to and provide access to it, and can provide its characteristics to other widgets, agents or data capture mechanism.
- They can provide specific and tailorable functionality to their owners and to visitors to the note, by presenting a user interface for getting comments, voting, rating, accessing data, displaying data, etc.
- They may have autonomous behaviors based on events, conditions, or times.
- They can store data which they will display or summarize when invoked (voting results, comment lists, timelines)
- They can communicate with members of the knowledge building community by means within the knowledge building system, or by external email.
- They can cooperate with other portions of the knowledge building system to construct and manage documents that facilitate the knowledge building process (to do lists, alerts, activity summaries, and evaluation summaries).

Can Meta-Communication Widgets Work?

We have proposed that knowledge building communication should be viewed as two separate classes of activity: 1) substantive content and 2) meta-communication that is used to conduct the knowledge building. We propose that the separation be represented by use of widgets to perform the meta-communication function; these widgets would be inserted into the substantive knowledge objects being built, and would provide computationally rich assistance to the knowledge building process.

The success of this proposal hinges on at least three conditions: Can such widgets be designed and implemented? Can the separation of process and product be successfully represented, taught, and used by learners? Does the separation and its representation provide more useful knowledge building, particularly in environments that do not provide a separate opportunity to manage the learning process?

The examples suggested above seem to imply feasible designs, and their implementation is easily within the capabilities of Web forms, CGI scripts, database-backed Web sites, and other current Web technologies and possibly Java applets, although the mechanism for exact placement within a text will be awkward with current HTML. Thus there seems to be no doubt about implementation in the Web environment. In the proprietary network-based learning software environment, implementation is equally possible, through it may be more difficult depending on the implementation technologies available.

The principal feasibility questions would seem to be centered on how to represent and teach the idea of meta-cognitive widgets to users of knowledge building systems. This involves design effort for the widget representation (their icons), their affordances, the visible effects they have, and the types of results that they produce. User training and motivation may be the biggest challenge, since it takes extra effort to learn new systems of representation and to understand when they are to be used (cf., the Belvedere system, Suthers, 1998).

Widget agency is also a design challenge. The proposed examples include many which initiate automatic events such as notification, logging, summarization, etc. These will lead to workflow design challenges which will require design sensitivity and tradeoffs to avoid introducing additional levels of information overload or perceptions of onerous requirements “to satisfy the system.”

Once a prototype system is developed that can be used, observations and research can be undertaken to determine if this is useful.

Conclusion

We have proposed extensions to a knowledge building learning environment, attempting to make explicit the learning principles underlying our design (Koschmann, in press). The proposal separates out much of the non-substantive communication in a knowledge building environment, thereby hoping to increase the focus on the substantive knowledge and understanding being developed. The separated communication has been termed “meta-communication”. Because much meta-communication makes an important contribution to the knowledge building, we propose that it be represented within the substantive documents through the use of knowledge-building “widgets”, displayed as icons, which are computationally rich and aware of the portion of the substantive communication to which they apply. Additionally, we have tried to illustrate

how the computational capabilities of the widgets can be used to enhance the knowledge building capabilities according to underlying principles. The use of these widgets is predicted to provide additional types of opportunities for participation in knowledge building, in part by offering a lower "cost" of entry into active contribution for those who might otherwise be "lurkers".

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