G. (PEDAGOGY TRACK): COMPUTER SUPPORT TO SCAFFOLD COLLABORATIVE LEARNING

Mapping Alternative Discourse Structures onto Computer Conferences

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ABSTRACT

In this paper, we describe a constraint-based discussion board that we have developed. A number of discourse systems have sought to constrain the ways that learners converse by requiring them to classify the nature of the comments and replies to others' comments. Those systems imposed a single constraint system on learners. In our system, we enable users to adjust the structure and content of the system in order to support a variety of discourses, including argumentation, problem-solution, literary analysis, and any other kind of activity. We describe the rationale for the system and will demonstrate the results of two discussions during the conference.

Keywords

CSCA, Alternative Discourse Structures, asynchronous learning

INTRODUCTION

Computer support for collaborative learning (CSCL) is a rapidly emerging paradigm. An important focus of CSCL work is the development of discourse systems such as KIE (Bell and Linn, 1997), CaMILE (Guzdial, 1995), and the Collaboratory Notebook (O'Neill & Gomez, 1994), and CSILE (Scardamalia & Bereiter, 1994) that are intended to scaffold domain-specific conversations and problem solving. This paper describes the development and initial implementations of a web-based environment for constraining conversations depending on the nature of the discourse you wish to support. We describe an asynchronous conferencing environment for supporting shared meaning making among members of collaborative groups with different learning tasks. Groups engaged in an activity (laboratory, simulation) or groups who have been presented with an authentic problem by their instructor need to discuss the activities or problems in different ways. While most scaffolded conferencing systems support a single discourse structure, the scaffolded discourse system that we describe can be adapted to support alternative discourse structures.

WHY ARGUE? WARRANTS FOR ARGUMENTATION SCAFFOLDS

Effective collaborations require not only convergent activities but also shared meaning making. This shared knowledge occurs through conversations about the meaning of the activities and their outcomes experienced by the collaborative group. The goal of that conversation and the collaborative inquiry process that engages it is consensus building, which is socially mediated through discourse (Meyer & Woodruff, 1995). Knowledge results from the gradual convergence of informed opinion. As learners develop new ideas and contribute them to the discourse, agreement emerges in the development of shared knowledge. That shared knowledge is created through a process of convergent understanding and "gradual refinement" (Roschelle, 1992). Since the knowledge is shared and owned by the discourse community, it is not only apprehended better by the members but also more likely to be appropriated by the members. Such knowledge is more meaningful and lasting to the members of the community than that which is dispensed by the teacher or professor, because the members own the ideas. Dispensed knowledge is not shared and therefore not as likely to be appropriated by members of the community, especially new members. Shared understanding through consensus-building also supports the mutual interdependence of members of the discourse community, which is an essential characteristic of collaborative learning that is too often ignored.

When collaborations involve problem solving, especially ill-structured problem solving, argumentation is required. Argumentation is a fundamental process of social negotiation through informal reasoning. Most attempts at negotiation do not expose people's informal reasoning processes so that the group can reason collectively. In order to support social negotiation, it is essential to make this informal reasoning explicit (Senge, 1990).

How do we facilitate learners' development of argumentation skills? Cerbin (1988) proposed that direct instruction on reasoning skills based on an explicit model of argumentation. Leeman (1987) and Saunders (1994) advocated using Toulmin's (1958) model of argument in law education class to develop argumentation skills. Several researchers have also advocated direct instruction on the structure and notation of argumentation (Knudson, 1991; Sanders, Wiseman, & Gass, 1994; Yeh, 1998). However, research findings show inconsistent results: direct instruction does not always improve argumentation skills as expected. Some research indicates that direct instruction enhances argumentation skills (Sanders, Wiseman, & Gass, 1994), whereas other research demonstrates no positive effects for direct instruction on improving argumentation skills (Knudson, 1991).

Technology can support social negotiation and the explication of informal reasoning in the form of argumentation through computer-supported collaborative argumentation (CSCA). CSCA scaffolds negotiation of solutions in problem-based learning, the situation in which we have chosen to implement our web-based argument tool.

CSCA AS SCAFFOLDING

CSCA scaffolds may be of two types, threaded and constraint-based. The threaded discussion is a simple form of hierarchically structured, textual argumentation provided by discussion boards or bulletin board systems (BBS) (Zumbach & Reimann, 1999). The threaded discussion shows the list of all the messages with headings, so learners do not have to search through old messages unrelated to the discussion topic. In a typical use of the threaded discussion, an instructor specifies a topic heading in advance and has learners associate their input such as opinions, messages, or issues with the topic. Their inputs are organized around topics and subtopics (Klemm & Snell, 1998) that emerge in the discussion. That is, the discussion is not prestructured. Thus, the threaded discussion provides a medium for topically organizing a discussion (Scardamalia & Bereiter, 1994).

The second kind of conversation scaffold is constraint-based. The concept of constraints has been used in a variety of ways in the psychology literature. Reading researchers have explored syntactic and lexical constraints on meaning generation while parsing sentences. In problem-solving research, constraints are the set of possible combinations of values between variables in the problem to be progressively restricted (satisfied) during problem solving (Darses, 1991; Richard, Poitrenaud, & Tijus, 1993). Chi, Slotta, and de Leeuw (1994) describe constraint-based interaction in defined systems that behave according to principled interactions or two or more values in the systems. These interactions can be defined canonically. It is important to note that these constraints are implicit in the problem. Any conceptual system (from a simple sentence to a complex conceptual domain) consists of attributes with values that interact. Those interactions impose constraints on the psychological processes required to operate on that system. Those constraints must be satisfied or eliminated in order for the processes to be completed.

Constraint-based CSCA conversation scaffolds, on the other hand, are prestructured forms of conversation systems that impose different conversational ontologies onto the discussion. These ontologies make explicit the constraints involved in the conversation. They supply the explicit statements of the interactions among the attributes in the domain. Users supply the values for the attributes. Preclassifying conversational attributes to fit these sets of canonical relations constrains the nature of verbal interactions among conversants. The Belvedere environment, for example, provides four predefined argumentation constraints ("hypothesis," "data," "principles," and "unspecified") and three links ("for," "against," and "and") (Suthers, 1998). These constraints form the links or relations between the ideas that conversants produce.

Many of these constaint-based CSCA systems have graphical interfaces that utilize node-link graphs representing argumentation or evidential relationships between assertions (Suthers, 1998). Like semantic networking tools that provide visual and textual tools for developing concept maps, these graphical interfaces provide learners with a visualization of an argument, so they can view the entire argument and manipulate it with ease (Suthers, 1998). Visualizing argumentation enables students and faculty to see its structure, thus facilitating its more rigorous construction and subsequent communication (Buckingham Shum et al., 1997). It also helps learners visualize and identify "the important ideas in a debate as concrete objects that can be pointed to, linked to other objects, and discussed" (Suthers & Jones, 1997, p. 1). The primary purpose of most constraint-based conversation systems to date is to support the student's ability to seek warrants as supporting evidence for claims. Bell and Linn (1997) suggest that conjecturing (with warrants, as opposed to descriptions) to support arguments provides evidence that students are making scientific conjectures, which enables them to generate more cogent problem solutions.

CONTEXT: SUPPORTING THE CONSTRUCTION OF SHARED KNOWLEDGE IN UNIVERSITIES

While the construction of shared knowledge occurs naturally in authentic work groups (project teams, scientific communities, etc.), the structure and methods employed in most university courses do not support these processes. Most instructional activities, such as laboratories and writing assignments, are individualistic. However, trends toward to the integration of active and collaborative learning methods in large universities are changing the activity structures of many courses. Unfortunately, many of those efforts are only marginally effective because the students do not construct shared knowledge through discourse processes about the activities. They may learn how to cooperate adequately through division of labor, but socially constructing shared meaning about their activities requires that they know how to discuss their activities in meaningful ways. More often than not, students do not possess these skills, largely because they have seldom been encouraged or required to meaningfully discuss what they are doing. Student opinions are not sought or valued.

IMPLEMENTATION OF CSCA ENVIRONMENT

The scaffolded discourse environment that we are testing is derived from a generic asynchronous conferencing forum. When creating a new forum in our environment, instructors first much chose whether to create a scaffolded forum or a generic forum (see Figure 1).

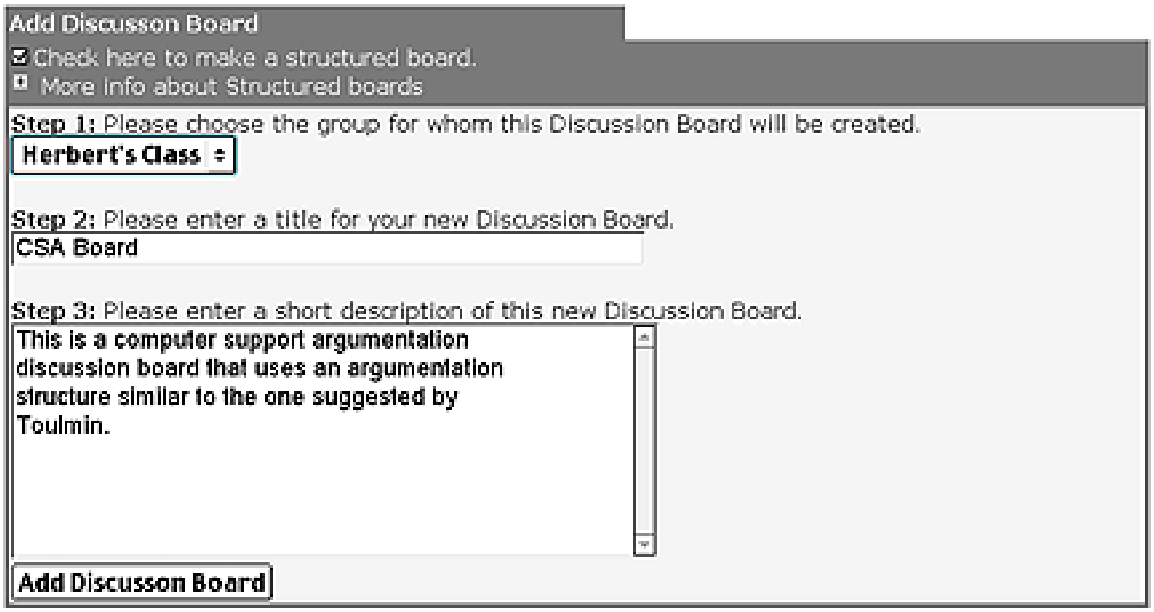

Figure 1. Creating a Discussion Board

If the instructor chooses to create a scaffolded forum, s/he must enter a title and description for the forum. Next, s/he defines the message types from which the student will be able to choose (ex: Problem, Solution Proposal, Support Proposal, etc.) and defines the name and the description for each message type (see Figure 2).

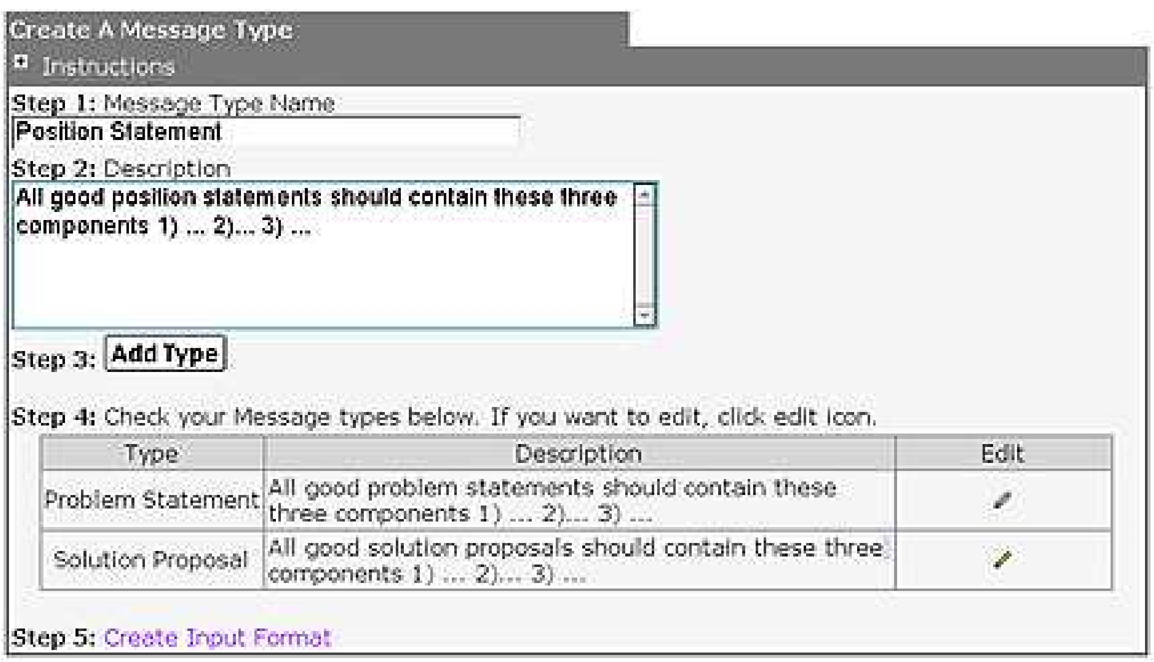

Figure 2. Creating Message Types

After specifying all the message types, the third step is to create the input format for each message type (see Figure 3). For example, an instructor can specify that all problem statements should be composed of a text block (a.k.a. text area in HTML) labeled "Problem Statement" and another text block labeled "People Affected by The Problem". Currently, the system only supports combining text blocks and text lines (a.k.a. text fields in HTML) to construct input types, but we anticipate enhancing the system to support other input types such as check boxes and pull-down menus. There is no limit to the number of text blocks or text lines that a message type can contain; however, all message types require a subject line.

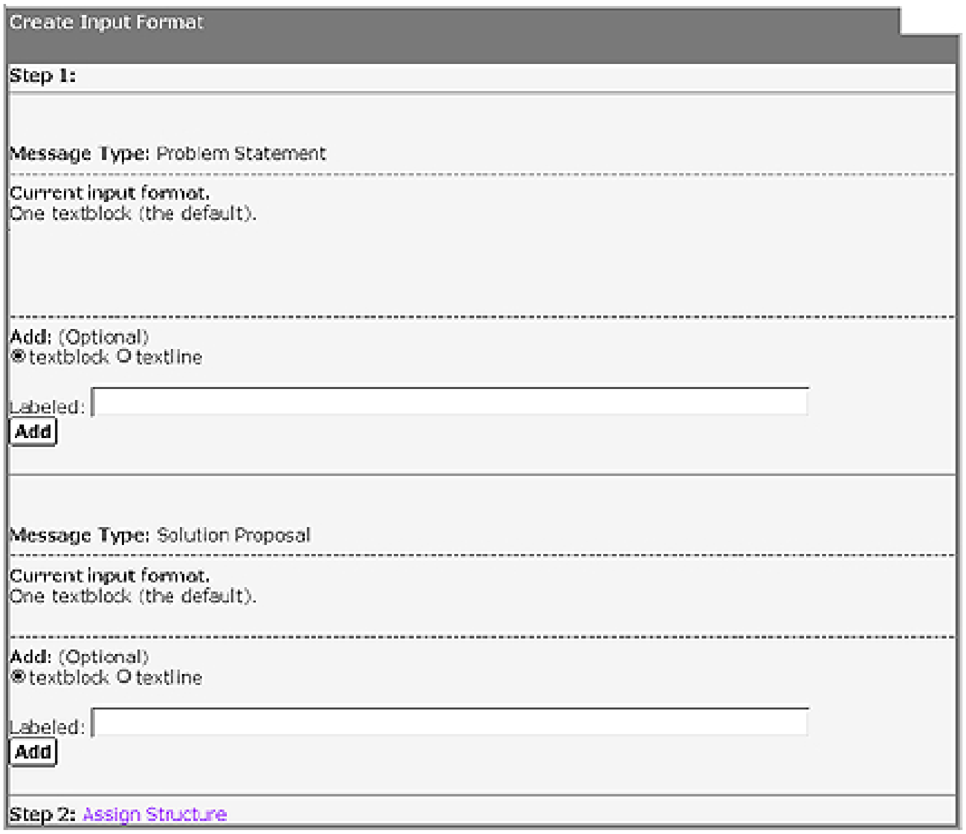

Figure 3. Creating the input format for message types.

The fourth step is to specify the relationships between the message types (see Figure 4). The instructor specifies the message type relationships by checking which message types are allowed to respond to other message types. For example, the discourse structure that we are testing defines 14 types of statements (see Table 1). Like Toulmin's argument structure, we have grouped the types of statements that make up an argument into four levels (problem, proposal, warrant, and evidence). The hierarchical structure that we have defined constrains users' comments and message response structures. At the problem level, the instructor posts a problem statement which student only can respond to using proposal-level statements. Proposal-level statements include solution proposals, position statements, and administration policy or law statements, and can be responded to with warrant-level statements. Warrant-level statements include support statements, clarify/re-interpret requests, rebut/reject statements, and problem redefinition statements. Warrant-level statements can only be responded to with evidence-level statements, which include facts/statistics/evidence, personal opinion/belief, personal experience/observation, theory/law, other's experience, and common knowledge. Although this defines the argumentation structure we have chosen to implement, the conferencing systems we are developing can be adapted to support multiple structures. After specifying the relationship the message types can take on, the fifth step is to create the board. In addition to supporting the creation of scaffolding structures, we anticipate the system supporting the ability to save, load, and share structures.

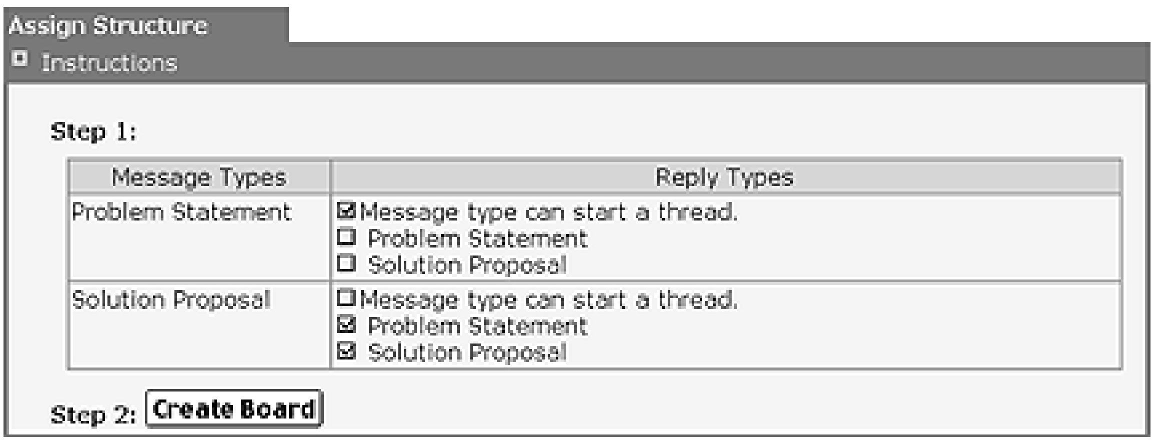

Figure 4. Defining relationships between message types.

The scaffolded discourse environment that we describe functions within the Shadow netWorkspace™ (SNS) (http://sns.internetschools.org). SNS is a Web-based work environment designed and developed to support schools and universities. Much like a personal computer's desktop SNS provides a personal workspace for organizing, storing and accessing files and an environment for running applications. SNS also provides the ability to create groups and for each group to have a "group desktop" for file sharing, communication, and collaboration. Because it is Web-based, teachers and students can access their workspaces from any computer that can access the World Wide Web, and partners (parents or mentors), who are unable to participate in schools because of time or distance, can participate in the netWorkspace. SNS is designed to be installed at individual school locations, has an Application Programming Interface (API) so others can develop applications for it, and is freely available under the open source (GNU Public License) so that anyone can participate in enhancing and supporting it. As with all SNS applications to date, the scaffolded discourse environment that we describe is available under the GNU Public License.

Problem Level

- Problem Statement

Proposal Level

- Solution Proposal
- Position Statement
- Administration Policy or Law

Warrant Level

- Support Proposal
- Clarify/Re-interpret Proposal
- Rebut/Reject Proposal
- Problem Redefinition Proposal

Evidence Level

Facts/Statistics/Evidence

Personal Opinion/Belief

Personal Experience/Observation

Theory/Law

Other's Experience

Common Knowledge

Table 1. Discourse structure being used in initial testing of scaffolded discourse environment.

ASSESSMENT OF LEARNING FROM SCAFFOLDED DISCOURSES

An important outcome of any professional education is the assimilation of the language and reasoning in the field. Students become scientists when they can use the language and discourse structures of the field to solve problems and engage in discourse communities about problems in the field. The scaffolding of that language acquisition and discourse structures is the purpose of the scaffolded discourse environment. Therefore, acquisition of those discourse structures will be the focus of evaluation. During the fall, 2001 semester, the scaffolded discourse environment will be implemented in two university classes, including an undergraduate teacher preparation class and an undergraduate course on comparative religions. Well-structured and ill-structured problems will be presented to students in each class. Their conversations will be monitored to see which structures are being used. Coaching, if needed, may be added to the environment to suggest the kinds of comments that need to be added to the conversation. These comments can be generated by a relatively simple intelligent agent that monitors the structure of the nodes in the conversation. Assimilation of language and discourse structures will be assessed in transfer tasks, which will be essays on student solutions to problems presented. The students' protocols will be analyzed by coding their essays using the argumentation structure used in the class.

Additionally, cognitive residue will be assessed by presenting problems in an unstructured discussion board. Conversations and essays will be assessed for the use of informal argumentation by classifying the number of claims, grounds, warrants, backings, and rebuttals found in student essays and in the unstructured conferences. Additionally, a protocol analysis of the essays and the students' contributions to the unstructured discussions will be coded according to the frequency of occurrence components of the problem-solving process using the Decision Function Coding System Categories (Poole & Holmes, 1995; see Table 2). A recent study showed significant differences in both argument structures and problem solving components between unstructured conferences and conferences scaffolded by Belvedere (Jonassen & Cho, in press). Their scores from the protocol analyses will be statistically compared to the number and proportions of statements from the unstructured computer conference. They will also be compared with essays from control groups who did not use the CSCA conferencing environment.

Results from these studies will be presented at the conference.

Problem Definition (PD)

Orientation (OT)

Criteria Development (CD)

Solution Development (SD)

Solution Approval (SA)

Solution Critique (SC)

Non-task Statements (NS)

Table 2. Poole & Holmes (1995) Decision Function Coding System

NEXT STEPS

Following the implementation and testing the scaffolded conferencing environment during the fall, 2001, we intend to develop alternative discourse structures and to implement those in other classes. Alternative discourse structures might include:

Argumentation:	Proposition, issues, positions, evidence, and arguments
	Major premise, minor premise, conclusion, Cause/effect
	Deductive: Rule-principle, premises, cases (instances)
	Inductive: Cases (instances), generalization
	Evidence: facts, opinions, stories

Illustration:	Example, similarity/dissimilarity
Problem/Solution:	Hypotheses, positions, arguments, evidence, conclusion, solutions, event conditions
Description:	Properties, characteristics, attributes, sequence, examples
Process:	System parameters, change, catalyst
Compare/Contrast:	Attributes, relationships, examples
Concept Elaboration:	Has analogy, has example, has attributes, has characteristics, has opposite
Decision Making:	Antecedent, condition/state, option, probable effect, weight
Case Analysis:	Problem, learning issues, rrgency, analysis, alternative, decision criteria, preferred alternative, implementation plan, missing information, assumption
Argument Analysis:	Questionable assumption, alternative explanation, counter example, evidence for, evidence against

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