

Work In Progress – Supporting Automatic Capture in Problem Based Learning Environments

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Abstract - Previous work at Georgia Tech has demonstrated the usefulness of classroom capture in traditional lecture settings [1]. Students use captured experiences in a variety of ways: study, reference, and exploration are a few. However, to provide ubiquitous and distributed support for capturing educational experiences, we need to extend capture to non-lecture learning environments. Study groups, Problem Based Learning (PBL) groups, tutoring sessions, individual study, and seminars are all examples of learning environments that are not lecture driven. In this paper, we describe the ongoing design and development of a system that automatically captures the meetings of a PBL group in biomedical engineering. We have based the system design on an initial study of student behavior in existing PBL groups and the ad hoc capture strategies that they employ. We discuss our observations and the resulting design criteria we have developed. We conclude with a description of the ongoing research and the next stage of experiments.

Index Terms – Capture and Access, Context-aware Computing, Problem Based Learning, Ubiquitous Computing

INTRODUCTION

This work represents part of an ongoing research initiative of the Arbutus Center for Distributed Engineering Education at Georgia Tech. By bringing together indexing techniques, digital signal processing technology, and capture and access research, we hope to make captured and authored content repositories a rich part of an enhanced learning environment [2]. The fusion of concepts terms with context information will provide useful access to captured learning experiences and supports the exploration and selection of related concepts from existing repositories.

INITIAL STUDY

We performed the initial study by observing students working in PBL groups, focusing on how they manipulated and coordinated information as individuals and as a group. The first observations were done in the meeting room with the students, the subsequent observations were done from behind a mirror in a PBL space designed specifically to support

observation. The PBL meeting rooms are small rooms for six to eight students that with floor to ceiling whiteboards on each wall.

The goal of the initial study was to understand the ad hoc strategies students use to capture and record information during the PBL session. This includes information that students brought into the classroom as a result of outside study as well as content generated during discussion. Capture techniques include individual note taking, digital pictures of the whiteboards at the end of the session, and a designated scribe providing a transcription of the whiteboard content as a Word document.

PHASES IN CONCEPT HANDLING

From our initial study, we have identified nine phases or tasks that are used to manipulate information in these sessions. The phases are interrelated and cyclic, but the order, after *Initial Exploration*, is not absolute. They are presented here in a functional order that seems to reflect many of the observed group sessions.

- **Initial Exploration:** Introduction of concepts, sampling of group knowledge, the initial forming of the groups understanding of the problem.
- **Identification:** The initial creation of a concept set that may be selected and explored.
- **Discussion:** A major element in PBL groups is the discussion process. Many of the other phases depend on discussion, but there is also a separate phase when concepts are “under discussion.” They have been identified, but not yet selected.
- **Assignment:** As the concept set grows, there begins a process of segmentation and ownership. Individuals or sub-groups are assigned or undertake responsibility for performing tasks on concepts and reporting back to the group.
- **Exploration:** This is the hunter-gather phase of concept manipulation. It is often the most time consuming. It is more in depth than the Initial Exploration phase, and is done as individuals and in groups.
- **Reporting:** In order to move information into a discussion phase, students must report the results of

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exploration. Some interesting techniques and reporting artifacts have been identified so far in this study

- **Selection:** In the selection phase, concepts are chosen for further exploration or discussion. Concepts that are not selected are often dropped from the group knowledge base.
- **Merging:** As individuals and sub-groups reconvene in the larger group setting, their concept sets need to be merged. The concept sets are presented in a reporting phase, move into a discussion phase, and often go into assignment and the exploration.
- **Known:** Concepts that the group feel are now generally “understood” are discussed and a consensus is reached that the concept is now known. This forms a subset of the concept set.

CAPTURE SYSTEM DESIGN

Our design of a system to support a PBL group focused on capturing the whiteboard content and the audio discussion to make these available to students outside of the PBL group session. We developed the prototype system using the InCA architecture, which supports the development of capture and access applications [3]. Our initial prototype used Mimio board capture hardware to archive the board content. An embedded microphone in the ceiling was used for audio capture.

The use of Mimio devices proved to be problematic. We were able to integrate four Mimio capture systems together to provide a large enough capture region for all of the whiteboards, however, the pen signals collided if more than one student was writing at the same time. Since this is a common occurrence in a PBL session, we were forced to abandon the use of Mimio capture devices in our system design.

The new prototype incorporates firewire cameras, and captures the whiteboards once every minute. The images from the screen captured are passed through an OCR based handwriting system, and discernable words are extracted. The collection of words is filtered using a stop list of common syntactic words, leaving a list of terms relevant to the discussion. The system tags each of the terms in this list with the timestamp corresponding to the time slice proceeding the whiteboard capture. This provides a link into audio file associated with the PBL session. With this system, students have access to the images taken of the board (in time sequence), the audio capture, and the terms associated with the individual images.

The system preserves the terms and related media components in the context of the learning experience in which they were used [4]. As students use the terms for later exploration of exiting repositories, we will provide the ability to maintain the connection between the two experiences using the *Concept-Context Cache*, discussed briefly below. By maintaining the connection between terms and the learning experiences in which they are used, we hope to support the idea of a larger learning framework in which concept

interconnections grow with use, and form a rich lattice of relationships.

Additional Technology

In addition to accessing the audio via time stamped terms, we are currently incorporating the ability to search the audio stream using word-spotting technology. This allows for students to enter their own terms, and find corresponding segments of audio, from a collection of group sessions, that match that term.

We are also experimenting with the use of intelligent pens, like ones produced by Logitech and Nokia. Student notes, either in our PBL study or in another classroom based experiment, are converted to web pages that interconnect identified terms with the captured session or lecture, as well as interconnecting to previous notes, course materials, and authored multimedia components.

The Concept-Context Cache (C3) is an agent based technology that actively maintains connections to content, relevant to a specific concept, and provided by a collection of federated repositories, as well as the context in which these concepts are being used. Each element within a C3 maintains knowledge of its conceptual identity, knowledge of relevant repositories, and the relationship of this concept with the individual learner and the other concepts in the learners C3.

ONGOING STUDY

The new system prototypes will be used in the Fall of 2004. The study method will include continued observation, open interviews with students, and interviews and questionnaires with the PBL facilitators.

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