# INTERACTIVE VIDEO ANCHORS IN PROBLEM BASED SCIENCE LEARNING: IMPLICATIONS FOR EDUCATION INVOLVING NANOMATERIALS

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## INTRODUCTION

This paper will review trends in research in interactive video technology anchors in problem-based science learning with implications for science education involving nanoscale materials. Interactive video technology has become an integral part of education due to developments in learning theories (e.g., Anchored Instruction, Situated Learning) to complement developments in technology- based tools (e.g., interactive videos) as anchors for problem-based learning in the late eighties and nineties.

## PROBLEM-BASED LEARNING

Problem based learning involves creating an active learning environment where students are engaged in learning by solving problems that they can relate to the context of the world around them and see as meaningful while gaining useful knowledge. Transfer is an advantage of useful knowledge that it can be retrieved/accessed in the context in which it was learned as well as in new contexts (Serafino & Cicchelli, 2003; Bransford & Schwartz, 2002; CTGV, 1993). On the other hand as Whitehead (1929) argued passive learning leads to inert knowledge, which may be defined as the knowledge recalled under explicit conditions, but not applied spontaneously in solving problems under normal circumstances. Inert knowledge, believed to be a part of semantic memory, lacks autobiographical references. Augmenting and enriching the context of learning might provide schema (mental associations) that help the learner create autobiographical references to new information. Later Dewey (1933) suggested theme-based learning in which the emphasis is to arrange related topics together under a theme so that students see the relationships, similarities and differences between concepts. Seven years later, Gragg (1940) in the article "Because wisdom can't be told" published in the Harvard Alumni Bulletin advocated the using mini-cases as micro-contexts to enlarge the context of learning so students are able to solve large problems in smaller problem subsets.

## INTERACTIVE VIDEOS

Influenced by the writings of Dewey, Gragg, Barrow, and others on the critical importance of larger learning contexts, educators and researchers began to take a closer look at developing interactive video tools suitable for problem-based learning. Interactive videos have been in use in various forms for several decades, varying in the degree of user control and interactivity. Interactive videos range anywhere from interactive slide projectors and film loops to videotapes, discs, and CDs/DVDs. This technology in the 1980s and early 1990s included laser (video) discs (twelve inch diameter) controlled by a remote control, bar code reader, or personal computer. By the late nineties and early twenty-first century, interactive videos were mainly CDs and DVDs controlled by a personal computer, or a stand-alone CD/DVD player run using a program stored on the CD/DVD. Some of the advantages of videos include visual, dynamic, spatial, and veridical representation of information (Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987; Sharp, Bransford, Goldman, Risko, Kinzer & Vye, 1995). Videos provide random access and more user control. With respect to problem-based learning video technology is tool for creating "macro-contexts" (e.g., Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987; Sherwood, Kinzer, Hasselbring, and Bransford, 1987; and Sherwood, Kinzer, Bransford, and Franks, 1987).

## MACRO-CONTEXT

Macro-contexts are realistic contexts that encourage the active construction of knowledge by learners, and differ from "micro-contexts" (information poor, mostly unrealistic contexts) found in educational technologies of the past. Traditional methods of using videos as micro-contexts mainly serve as visual supplements to lectures and offer students disconnected contexts or situations with the assumption that the student is simply learning from the experts. Macro-contexts, on the other hand, provide a video based context deliberately embedded with data to enable the learner to immerse in an information rich audio-visual environment, revisit the same information from multiple perspectives, and work towards success while developing expertise. The introduction of macro-contexts through videos provided "new directions" for using videodiscs in education (Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987). Some of the key developments in contemporary learning theories such as "anchored instruction" and "situated learning" during the mid to late eighties could be attributed to the idea of interactive video based macro-contexts. Brown, Collins, and Duguid proposed the idea of situated learning, also known as situated cognition. Proponents of situated learning posit that learning is different in different learning situations. To facilitate learning, proponents of this theory recommended creating apprenticeships representing authentic tasks involving "ordinary practices of the culture" (p. 34). Though critics (e.g., Tripp, 1993) might tend to differ, this theory has grown in acceptance since 1989, particularly thanks to research and development in macro-contexts and subsequent anchored instruction using interactive video technology.

## ANCHORED INSTRUCTION

A hybridization of hybridize principles of situated learning and the idea of macro-contexts with the aid of interactive video technology in problem based learning resulted in anchored instruction (Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987; Bransford & Sherwood, Vye, & Rieser, 1986; Kinzer, Risko, Vye, & Sherwood, 1988; Risko & Kinzer, 1989; Bransford, Sherwood, Hasselbring, Kinzer, & Williams, 1990; Cognition and Technology Group at Vanderbilt, 1990). In anchored instruction, the videos serve as anchors for placing problem based learning in a context often deliberately enriched with data necessary for solving problems. Anchors are stories and episodes. For details on the effect of anchored instruction on improving problem-solving abilities see The CTGV (1990). Problem-based anchored instruction is critical to developing ability to transfer learning to similar situations.

Interactive Video Anchors Using Movie Clippings. Efforts to design interactive videos as anchors originated from teaching science, language arts and history to fourth through sixth grade students. Selected movie clippings from movies such as "Raiders of the Lost Ark" and "Young Sherlock Holmes" were used as anchors.

## LEARNING SCIENCE WITH THE "RAIDERS OF THE LOST ARK"

In the "Raiders of the Lost Ark" movie, in one scene, Indiana Jones is attempting to take control of a golden idol resting on a pedestal tied to a booby trap (Sherwood, Kinzer, Hasselbring, Bransford, Williams, & Goin, 1987). He removes the idol from the pedestal and quickly replaces it with a bag of about the same size containing sand. According to Sherwood, Kinzer, Hasselbring, Bransford, Williams, and Goin (1987), upon viewing this clipping, for example, students begin to infer that the idol must be made of gold, and the sand bag and the idol weigh the same. Encouraging field test results of such approaches to using interactive videos for creating meaningful macro-contexts provided a rationale for additional research in interactive video based anchors in problem-based learning.

## INTERACTIVE VIDEO ANCHORS USING CUSTOM MADE EPISODES

The successful outcomes of the uses of movie clippings as video anchors encouraged researchers to custom develop episodes focused on three areas; mathematics, science and language arts. The first two in a series of episodes in the Jasper Series, "Journey to Cedar Creek" and “Rescue at Boone's Meadow” were custom produced for anchoring problem based learning. The adventures provide "multiple opportunities for problem solving, reasoning, communication and making connections to other areas such as science, social studies, literature and history" (The adventures of Jasper Woodbury (1)). In the episode "Journey to Cedar Creek," "students meet Jasper as he reads a newspaper advertisement for an old boat for sale. Jasper decides to see this boat, and we follow him up the river to Cedar Creek Marina. He test drives the boat, and learns the running lights don't work.

He decides to buy the boat. Students are challenged to help Jasper determine if he can make it home before sunset and without running out of fuel" (Three Jasper adventures in trip planning, no page number). As with any Jasper episodes, students are challenged to generate subproblems, locate appropriate data, perform the necessary calculations, and solve this 15-step problem. According to the Cognition and Technology Group at Vanderbilt (1990), the Jasper videos are embedded with data necessary to make critical decisions. The availability of data at students' disposal enables them to decide what information they need to know and retrieve from the video to solve problems. Some of the mathematical skills involved in solving the Journey to Cedar Creek episode include whole number operations, decimals, fractions, percent, ratios, proportion, length, area, time, map reading skills, and problem solving.

## INTERACTIVE VIDEO ANCHORS IN SCIENCE

Insights from the Jasper Series in mathematics problem solving complemented earlier efforts in science generated interest in custom producing interactive video anchors in science. For example, the first two in a series of episodes in the Jasper Series, "Journey to Cedar Creek" and 'Rescue at Boone's Meadow" were custom produced for anchoring problem based learning. The adventures provide "multiple opportunities for problem solving, reasoning, communication and making connections to other areas such as science, social studies, literature and history" (The adventures of Jasper Woodbury (1)). Another development in this line of research is the "Scientists-in-Action" project which involves four episodes ("Stones River Mystery," "Return to Rochester," "Lost Letters of Lazlo Clark," and "Border Blues").

The pedagogical attributes of the Scientists-in-Action video-based problem solving in science follow. Students are posed with several challenges over the course of the episode which helps them to play an integral part of solving the problems similar to the scientists in the video. Subsequent developments include the application of the STAR Legacy Cycle format (Schwartz, Brophy, Lin & Bransford, 1999) to the above video based problem solving in science. The STAR Legacy Cycle is a flexible software shell that empowers teachers to adapt pedagogically sound instructional design, increasing the "power of anchored instruction" (Sherwood, 2000). The STAR Legacy Cycle River of Life simulation involves the "Legacy League" characters, a multiethnic group of "twenty-somethings" who help students tackle real-world problems and develop better attitudes toward learning. The simulations involve water quality analyses such as Issac Walton method of calculating water quality index based on the number of macroinvertebrates. The simulations are a source of cost-effective means of combining several learning strategies, based on participation in the problem solving process at intermittent periods during learning. Sherwood (2001) found that fifth graders in a study using pre- and post-tests showed an increase in their understanding of the significance of macroinvertebrates and dissolved oxygen in water quality measurements. Kumar and Sherwood (in press) in a study of the "River of Life" among preservice teachers noted the following outcomes. The simulation had a significant effect on the conceptual understanding in the composition of air, macroinvertebrates, dissolved oxygen, classes of organisms that form a river ecosystem, and graph reading skills. A delayed post-test gain was evident in the water quality and near transfer subsets than the dissolved oxygen subset. And, students were able to transfer knowledge acquired from the multimedia simulation on more than one concept into teachable stand-alone lesson plans.

## SUMMARY AND IMPLICATIONS FOR SCIENCE EDUCATION INVOLVING NANOMATERIALS

In a relatively short period of time research has literally shaped the course of interactive video technology in problem-based learning. Meanwhile, consider recent developments in nanoscale materials science and technology dealing with particles of 1-50nm in size; nanocrystals, quantum dots, nanotubes, etc. They “exhibit properties entirely different from bulk materials and constitute materials of the future” (Rao, 1999, p. 59). For example, a decrease in size facilitates the manifestation of more quantum effects in the form of optical, electrical, and magnetic properties. Nanomaterials science is an interdisciplinary field and provides problem based learning opportunities in science. Some of the topics may include energy production, conservation and storage, controlling air pollution, treatment and remediation of water, monitoring health, processing and storing food, and construction (BBC News, 2005). Research and development efforts have taken interactive video technology to new heights, and it has become a powerful cognitive tool for problem-based learning in science. Whether interactive videos provide a suitable cognitive tool for problem-based learning involving nanoscale materials is an interesting question that should be addressed in its entirety.