Online Journal for Workforce Education and Development

Volume 1
Issue 1 *Spring 2005*

Article 5

April 2005

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CONTEXTUAL TEACHING WITH COMPUTER-ASSISTED INSTRUCTION

ABSTRACT

Computer technology has made substantial contributions to education and educators are now confronted with determining how to best incorporate it as a teaching tool. Educators have also long struggled with how to make what is learned in school more useful in other contexts. This review of recent literature was undertaken in an attempt to determine if computer-assisted instruction is compatible with contextual teaching and learning approaches. The four computer-assisted assets of flexibility, format, interactivity and navigational methods were examined because they yield the most interpretive evidence of compatibility with contextual teaching and learning approaches and their characteristics. It was concluded that all four of the assets identified were compatible and should be included within contextual approaches.

INTRODUCTION

"For much of the past century, educators have struggled in various ways with trying to make what [students] learn in school more accessible and useful in other contexts" (Borko & Putnam, 2001, p. 35). Several studies have suggested that when skills are taught in the context of competencies, students learn the skill more rapidly and will be more likely to apply it in other situations (Hersh &Sears, 2001). Educators and policy makers alike agree that technology needs to be effectively integrated into education at all levels of our schools, colleges, and university systems. It seems obvious now that the use of computers in education is an inevitable experience. Educators are now confronted with determining how to incorporate technology as a teaching tool.

CONTEXTUAL TEACHING AND LEARNING

Contextual teaching and learning emphasizes high order level thinking, knowledge, transfer, electing, analyzing, and synthesizing information and data from multiple sources and viewpoints (Hally, 1989; Smith, 2000). John Dewey, who advocated a curriculum of teaching methodology tied to a child's experiences and interests, first proposed the application of contextual learning to American classrooms. Dewey also deplored the separation of education into mind and body and of school programs into academic and occupational treks (http://www.cew.wisc.edu/teachnet/ctl/). Contextual teaching and learning represents a concept that involves connecting the content, the student's learning, with the context in which the content will be used. Connecting content with context is important to bring meaning to the learning process. For that connection to take place, a variety of contextual teaching approaches may be used (Putnam, 2000).

Learning in multiple context draws upon current theories of cognition and learning suggesting that knowledge and learning are considered to be situated in particular physical and social contexts (Borko & Putnam, 2001). Theories of situated cognition assume that knowledge is inseparable from the context in activities within which it develops. “Thus, how a person learns and a particular set of knowledge and skills and that the situation in which a person learns is a fundamental part of what is learned” (Hersh & Sears, 2001, p. 7). Examples of meaningful context include families, museums, libraries, businesses, and other parts of the community.

According to Hersh and Sears “Students are part of the context we teach” (2001, p. 8). On a whole, the student population is becoming very diverse. With increased diversity comes differences in values and perspectives that can add complexity to the contextual learning experience. “Team collaboration and group learning activities respect student’s diverse histories, broaden perspectives, and build interpersonal skills” (http://www.cew.wisc.edu/). Because a student’s cultural and social context is an inherent and deeply structured context, it automatically informs and connects to all learning. It can therefore be used as an instructional platform to allow students to move from what they know to what they do not know (Hersh & Sears, 2001).

CONTEXTUAL LEARNING APPROACHES

The two most often cited methods of contextual teaching approaches found in the literature are problem-based learning and collaborative/cooperative-based learning. In problem-based learning, students are encouraged to identify and evaluate existing knowledge and skill resources and then to make the best possible use of them. Resources include printed materials, a computer media, and human resources (Barrows & Kelson, 1996). It includes many of the features of other contextual approaches and has been adopted as a curriculum delivery model in many professional schools around the world (Putnam, 2000). The PBL process incorporates six dimensions: a.) modeling the scientific method reasoning process, b.) simulating in students the need to develop sound knowledge from which problems can be resolved, c.) developing the skills in student for life-long learning, d.) developing the skills in students to work as members of the collaborative team, e.) developing students who take responsibility for the improvement of their community as well as themselves, and f.) developing students who may have the propensity for honest reflection and can also set realistic goals (Barrows & Kelson, 1996). It is particularly well-suited for technical and medical education. The main advantages of problem-based learning are that it uses real world problems as context, emphasizes problem-solving skills, teaches critical thinking skills, develops self-directed learning skills and employees authentic assessment. (Putnam, 2000).

Problem-based learning is an instructional approach that uses real-world problems as the context for students to learn critical thinking and problem-solving skills and to acquire knowledge-essential concepts of the course. Problem-based learning can begin with either a real or a simulated problem. Students then use critical thinking skills to lead them to a systematic approach of inquiry and to address the problem or particular issue. To solve these problems students may also draw upon multiple content areas and sources (Barrows & Kelson, 1996). “Student wrestle with the problem [and] begin to realize that it can be viewed from very different perspectives and that to resolve the problem they need to integrate information from various disciplines” (Jones & Pierce, 2001, p. 70). Students engage in higher-level thinking and problem-solving as they assume roles of stakeholders who were affected by the resolution of the problem (Hersh & Sears, 2001). “The constructionist view of learning holds that meaningful learning occurs when students have to use previously learned knowledge and skills to solve realistic problems in a realistic context” (Biehler & Snowman, 1997, p. 365). Worthwhile problems that are relevant to the student such as school and family experiences may hold greater potential meaning for students.

“Engagement in cooperative learning structures such as cohort groups appears to be an ideal means of encouraging independent learning” (Hersh & Sears, 2001, p. 8). Collaborative/cooperative learning is an instructional approach that uses small groups in which students work together to maximize their own and others’ learning. Collaborative learning emphasizes teamwork and takes advantage of peer tutoring. Collaborative learning experiences can be added to many teaching units. Collaborative learning problems appear to work best when the learning objective involves students analysis of a systems problem. The keys to success are team-learning and peer tutoring, so group selection and team building are critical. An example for younger students might include having small groups conduct a task analysis of assembling and disassembling a mechanical pencil. The advantage of collaborative/cooperative learning is the use of small groups, which work together, and students maximize their own and each other’s learning (Putnam, 2000). Hersh and Sears (2001) believe that interaction between students and environment may be major a determinant of what is learned and how learning occurs.

COMPUTER-ASSISTED INSTRUCTION

Proponents claim that computers make learning easier, more efficient, and more motivating (Fagnano & Schacter, 1999). In many cases, it is the learning approach that determines the failure or success of the technology innovation (Means & Olson, 1995; Seely, 1995). While trying to define computer-assisted instruction, it becomes clear that there are many terms that are related such as, computer-based instruction, computer-based training, etc. In this paper we will use the term computer-assisted instruction to refer to any use of computers that interacts with students in any way in the educational process. For comparative purposes, we will use the four computer-assisted assets of flexibility, format, interactivity, and navigational methods, because they yield the most interpretive evidence of compatibility with contextual teaching and learning approaches and their characteristics.

FLEXIBILITY

Students learn in different ways and at varying paces (Gardner, 1997). Effective instructional technology must, therefore, take advantage of maximum flexibility. On-line computing, floppy disks, CDs, videos, and electronic conferencing by telephone, television, or desktop computer may be accessed in libraries, in laboratories, in the workplace, in the home; basically anywhere the appropriate technologies are available. “Digital storage media such as hard disks, floppy drives, CDs, web sites, e-mail, and videos may be accessed at a time convenient to the learner” (Inglis, et. al., 1999, p. 19). The result of digital storage also allows for greater freedom of pace than modes of study involving class attendance.. “Where designed with alternative paths or modules, digitally based learning programs can readily accommodate prior learning and offer alternative entry points, possibly based on an incorporated pre-test of understandings and competencies" (Inglis, et. al., 1999, p. 19). Digital programs may also be constructed to allow users to select alternative topics, paths or sequences, and to multitask while using others programs at the same time (Inglis, et. al., 1999).

FORMAT

The format in which content is displayed on the screen is an area in which recent studies have been conducted, and conclusions appear to favor a mixed format. One experimental study found that combining forms of media to relay information was more effective than using either of the two forms alone. Mayer & Anderson (1991) had college students listen to a verbal description at the same time that they watched an animation explaining how a bicycle pump works. Other groups listened only to the audio explanation, saw only the automation, and had no instruction at all. On a problem-solving test, those students who received the combined form of instruction performed better than the other groups.

"Multimedia is a class of computer-driven, interactive communication systems which create, store, transmit, and retrieve textual, graphic, and auditory networks of information" (Gayesky, 1993, p. 4). The benefits of multi-media learning are sometimes explained in terms of the dual-coding theory. It is suggested that we process information through two independent channels; one channel for verbal information and another for non-verbal or visual information (Clark & Paivio, 1991). When instruction is presented in such a way that both channels are used to take in the same information it is termed referential processing. It is believed that referential processing has an additive affect on recall perhaps because the learner creates more cognitive paths and therefore it is easier to retrieve information. "Multi-media technologies have great potential to empower learner's mastery of higher order thinking skills" (Gayesky, 1993, p.115)

Looking a little deeper into the question of dual coding, Ollerenshaw and Aidman (1997) researched whether prior knowledge and learning style impact the affects of referential processing and learning outcomes. This experimental study supports the notion that textual learning is generally enhanced by the inclusion of multi-media illustrations, but students' learning styles and prior knowledge can play a significant role in their effectiveness. Both low and high prior knowledge learners scored higher when tested on information that was presented using referential processing. However, low prior knowledge learners did significantly worse when information was presented in any of the three formats that did not allow dual coding of the information.

In a review of studies, Hartley (1999) discussed the importance of considering cognitive load when designing multi-media instruction. Like dual coding, cognitive load theory recognizes that we have the ability to learn using both auditory and visual means. Cognitive load theory also recognizes a third component of working memory, the executive system that is tasked with manipulating and coding information. According to Hartley's discussion, working memory has a limited capacity and both intrinsic and extrinsic demands may interfere with the processing of information. Intrinsic demands are those that are directly related to the difficulty of the information being studied. Other unrelated demands upon working memory are considered extrinsic and should be controlled.

INTERACTIVITY

Interactive multi-media is a computerized database that allows users to access information in multiple forms including text, graphics, video, and audio (Gayeski, 1993). When the user clicks on a link, the program navigates to the select section of the program. Other forms of interactivity exist that may enhance the educational experience (Najjar, 1996). For instance, the user may be required to type a response to the question in order to proceed with the instruction or perhaps a user may be required to move objects on the screen in order to demonstrate an understanding of relationships between items. One possible explanation for the effectiveness of interactivity is its ability to provide feedback and reinforcement. Computers can provide some particularly effective methods of delivering drill and practice exercises especially to the motivational qualities and the ability to provide immediate feedback (Balajthy, 1989). Interactivity can be seen as an integration form of Gagne's events of instruction, eliciting, and assessing performance (Stemeler, 1997). Navigation is one form of user and program interactivity.

The design of any computer-assisted instruction must focus upon the concepts that have been explained. It is a combination of these principles and their impact upon user behavior and attitudes that most experimental research is currently directed towards.

NAVIGATIONAL METHODS

Navigation refers to the method in which the individual progresses through the content of a multi-media or hypertext program. Aids to navigation are obviously an important consideration in any program and their design should correlate with user abilities and the type of interaction required. Taylor, Sumnar, and Law (1997) offer a good synopsis of navigational aids; "Designers therefore need to know what kind of activity is the principle focus in a given system and should provide interface support appropriate for this activity." (p. 231)

One of the many problems associated with navigation is a possibility of disorientation (Evans & Edwards, 1999; McDonald & Stevenson, 1999) and as a result, programs often utilize some sort of structural map or index in order to familiarize students with the information available and to highlight the logical connections between different sections of the material. If the end user cannot easily locate the information that he or she seeks, then the effectiveness of the instructional product suffers (Evans & Edwards, 1999; Stemler, 1997).

A simple linear approach is a navigational design that users can easily comprehend because it is quite similar to the reading of traditional text from beginning to end. Each new chapter builds upon information taught in previous lessons. Movement is possible in either direction, but there is no navigation available between similar ideas or concepts within any section. A strictly linear approach is very limiting and does not take full advantage of the possibilities offered by multimedia.

Hierarchical navigation applies movement from the general to the specific. Users follow a path of information that becomes increasingly narrow, returning to a central location to follow the next path. Specific concepts presented in the hierarchical approach are not linked and may seem unrelated.

A simple web pattern of navigation allows users to access any area from one central location. This pattern can be effective for smaller amounts of information where a single computer monitor screen illustrates each concept. But, again, there is no relationship fostered between the concepts presented within each screen frame.

More complex navigation can be introduced in any of these illustrative models by allowing users to link to other screens containing related materials. For instance, in the linear model, the user could be offered the option of linking from screen one to screen four in order to view the relationship between the concepts presented. Removing the requirement of constantly moving to the main screen offers more user control, but also may cause greater confusion and increases the risk of missing entire portions of the instruction.

COMPATIBILITY OF CONTEXTUAL LEARNING AND COMPUTER-ASSISTED INSTRUCTION

In an experimental study using twenty 11-year-olds, Chambers (1999) found that learners using a CD-ROM encyclopedia demonstrated critical thinking skills in the way they conducted the required searches. At first students would browse through large amounts of information, attempting to find the necessary answer, but almost all of the students quickly realized that using more search words would minimize the amount of reading. Chambers admits that previous knowledge was an important variable in the study, but even those students who had little familiarity with the use of such a database quickly adopted successful search strategies based upon evaluation of previous search results. Chambers compares this process to scientific inquiry which seeks to test a hypothesis by carrying out strategies and modifying them when unsuccessful. He suggests that in the process of using the multi-media database, students were learning information based on problem solving skills.

Another experimental study looked at how user behavior changed when the response time of the system was intentionally increased (Child, 1999). By studying the information locating strategies of 74 individuals, the researcher concluded that a short system delay resulted in more precise and careful research. When no delay occurred, learners frequently switched sections and sifted through lots of pages in search of appropriate material. But when a five-second delay was added, searches became more directed and learners remained focused and viewed longer strings of consecutive pages. For the designer of computer-assisted instruction, this suggests that if a system response is expected, then the knowledge base should be constructed to maximize this search strategy.

In a model developed by the Ontario Institute for Studies of Education (OISE) faculty developed a very effective model of inquiry that involves all of the elements of problem-based learning and more (Jones & Pierce, 2001). The process helped students find problems, develop theories and hunches, conduct inquiries, share results, and engage in knowledge building to approve the next cycle of thinking. "Thus the work takes place within communities of practice and there are progressively refined cycles of understanding about the problem or phenomenon under study" (page 77).

Several studies have concluded that computer-assisted instruction is potentially effective as a tool in assisting undergraduates to develop math competencies (Allen & Pappas, 1999; Cartwright, 1996). Students have the most difficulty with conceptualizing the problem when attempting calculations. Software programs can be supported with visual cues and link to problems to assist learners to relate abstract math to calculations such as medication calculations (Cartwright, 1996). Bayne and Bendler's (1997) study highlighted the problems associated with the introduction of computer-assisted instruction as a teaching tool for nurses with limited experience in computing.

Other factors impacting on the effectiveness of CAI, as identified by Yadrick, Regian, Robertson-Schule, and Gomez (1996) included the interface design, instructional approach, and suitability of a program to meet the learning needs of individuals. They also suggested that some students may feel overwhelmed by solving math on the computer. There exists the potential to access shareware programs through the Internet to verify calculations in laboratories, which may signal a trend towards the use of computers in clinical settings to assist nurses with more complex calculations (Baer, 1998). The use of a multimedia resource provides powerful advantages over early forms of computer assisted instruction in which students typed in answers and received a correct or incorrect response. The visual images which allow the students to see the actual equipment used, places the problems into a clinical context and how it relates to medical calculations (Berk et.al., 2000). Computer-assisted instruction can assume several forms, such as public conferencing by computer, interactive chat, personal and professional networking, scholarly collaboration, individual and group presentations, peer review of writing, research, peer tutoring, peer counseling, tutorial simulation, and drills and practice with emerging technologies (Chung, 1994; Berg & Collins, 1995; Santoro, 1995).

CONCLUSIONS

According to our review of recent literature, it can be seen that computer-aided instruction is very compatible with contextual learning approaches. All four of the computer-assisted instruction assets identified are compatible and should be included within the contextual approaches identified.

The flexibility of computer-aided instruction provides immediate feedback and reinforcement which motivates and facilitates self-regulated learning. Multi-cultural students can collaborate and contribute within social barriers. Students can employ authentic assessments of themselves and others through the collection of sources such as journals and storage of digital information through informatics and collected learning over time. Students can collect information in multiple contexts and formats such as information from museums, libraries, and businesses that have informational web sites and can be collected from textual, graphic, and auditory networks of information. Interactivity allows problem-solving and collaborative/cooperative students to interact by e-mail and to access information in multiple forms. The navigational methods employed, which are another form of interactivity by computer-assisted instruction, facilitate research methods that are compatible with searching for answers to problem-based and collaborative/cooperative based approaches. Because of the similarities of both contextual learning approaches, the computer assisted instruction assets identified should be exploited when considering the design of all contextual instruction to ensure effective life-long learning.

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