On-line Multimedia Assessment for K-4 Students

Abstract:

The current mandates of the "No Child Left Behind Act", as well as the emphasis on standards and data-driven decision making, have dramatically increased the importance of K-12 assessment. On-line assessment, with its advantages of easy grading and immediate feedback, is becoming more common, but there is growing recognition that efforts need to go beyond computerizing multiple choice tests to the development of assessments that capitalize on the computer's multimedia capabilities and facilitate learning in ways that paper measures cannot (Bennett, 2002). Another issue is that little work has been done with younger children, and particularly non-readers. This paper describes a multi-state project for the development of assessments embedded into multimedia instruction designed for K-4th graders. Results from classroom utilization of the materials show that on-line assessment technology can be successfully used with young children and multimedia activities provide a rich context of assessment information. On-line technology is a useful tool in the organization and presentation of that information both to the learner and to the teacher.

Project Overview and Goals:

The Bridges project is a U. S. Department of Education multi-state project designed to help teachers and parents of K-4th grade children more effectively use technology to improve student literacy. The project utilizes media resources developed around the award-winning children's television program, Reading Rainbow. Winner of eight Emmys for Outstanding Children's Series, Reading Rainbow is a PBS series intended to make reading and literature fun and engaging. Hosted by LeVar Burton, each show features a television adaptation of a children's picture book. Reading Rainbow is the #1 most watched program in the classroom (CPB, l997).

The Bridges project drew upon previously produced Reading Rainbow television programs/videotapes, but supplemented these resources with fun, engaging multimedia activities for students based on the content and topics of the television programs. A major component of the project was the development of student assessments, correlated with state standards, which were embedded into the interactive exercises. As students complete the interactive activities, their responses are tracked, analyzed, and made available to teachers through an assessment web site. The assessment component involved three objectives: (1) to develop on-line assessment activities to support Reading Rainbow program content (these were the interactive exercises) ; (2) to develop on-line assessment tools for teachers and researchers/developers; and (3) to determine the effectiveness of the on-line assessment materials and tools both from a learner and teacher perspective. A major goal of the project was to determine if we could develop an on-line assessment process that could successfully be used by younger children, provide valuable feedback to the teachers in real-time, and be used by children and teachers located in multiple states.

Development of the on-line assessment tools drew upon previous work conducted by the University of Nebraska-Lincoln's National Center for Information Technology in Education (NCITE) with tenth grade web-based physics instruction utilizing on-line assessment. This earlier work, funded by the National Science Foundation, provided the conceptual basis for the assessment component of the Bridges project. Because the Bridges instructional material was designed for a much younger audience and incorporated more video/graphic/animation material manipulated by a mouse rather than keyboard response, new software routines and programs had to be developed, however.

The Project Partners:

Bridges is a public television initiative involving three primary statewide networks: Maryland Public Television, GPN/Nebraska Educational Telecommunications, and South Carolina ETV. Each of these entities has a long history of innovation using digital media and the Internet to provide services to teachers, students and parents. In addition, there are five other affiliated public television partners: KRMA/Denver;

KERA/Dallas; WSIU/Carbondale, WNED/Buffalo, and WHYY/Philadelphia. By the time the project is completed in June of next year (June, 2003), approximately 480 teachers in nine states will have used the materials in their classrooms, with 20 projected to be involved in the assessment. The on-line assessment component has been led by NCITE.

Instructional Approach:

Recognizing the unique needs of a K-4 audience, the project was guided by several underlying principles reflective of the growing body of research on human learning and assessment. In addition to being learner-centered and knowledge-centered, effectively designed learning environments must also be assessment centered, providing opportunities for learners to test their understanding and receive feedback. Feedback should also be provided to the teacher regarding the level of student understanding and the need for instructional intervention. Clearly on-line technology can be a valuable tool in the area of formative assessment, using the ability of the computer to track student response, perform statistical manipulations, and provide real-time results to the teacher about both individual student and class progress.

The following principles were used to guide the development of interactive activities used in content presentation and assessment, as well as the assessment tools themselves. The goal was to effectively use technology to create learning environments which maintain student interest and motivation, facilitate learning, and reflect the realities of classroom practice.

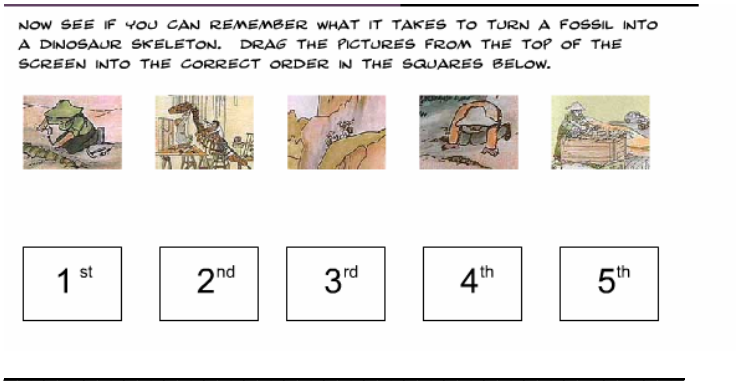
Design Principle 1: Rich multimedia content, effectively combining audio, print, and pictures (both graphics and video), can promote student engagement and learning at the K-4 level.

Cognitive theories of multimedia learning draw on several theoretical assumptions, including the existence of dual channels for processing pictorial and verbal information (Paivio, l971), limitations in the amount of information that can be processed in each channel at one time (Baddeley, l992), and the need for active processing to make sense of the multimedia message (Mayer, l999). The instructional value of combining print, audio, and pictures, as well as the superiority of narration versus textual presentation, has been established for younger audiences (Nugent, 1982). Other research with three to five year olds has shown that multimedia technology, with its use of video, audio, and graphics, can engage children for long periods of time (Liu, l996)

In designing the student interactive activities, the development team made extensive use of graphics and animation, but also provided opportunities for students to select text and audio cues depending on their reading skills. Audio presentation of the instructions for completing the activities was critically important for non-readers.

Design Principle 2: Assessment activities are embedded within the instruction itself, not presented as a separate “test”.

Tying the assessments to the instruction reflects the premise that educational assessment does not exist in isolation, but must be aligned with curriculum and instruction if it is to support learning (Pellegrino, 2001). In this project the assessments were integrated or embedded into the instructional activities. For example, in one activity students are presented with illustrations from the Reading Rainbow book and accompanying text or narration describing the event depicted in the illustration. Students are asked to sequence or order the pictures to reflect the story events. Using drag and drop techniques, students assemble the pictures in the correct order.



The computer tracks student mouse clicks and judges correct versus incorrect responses. Students are given the opportunity to try again if some pictures are incorrectly sequenced.

Design Principle 3: Gaming techniques are used to encourage student motivation and interest.

Many educational software developers have employed the use of gaming techniques in creating educational content. Malone's early work (Malone, 1981; Malone & Lepper, 1987) provides principles to guide development, maintaining that intrinsic motivation is a function of an optimal relationship between challenge, fantasy, curiosity and control. Achieving this optimal relationship results in the game being fun. A major stipulation of the development team was that activities for the students be fun and engaging, and gaming techniques proved to be an excellent way to gain and maintain student attention.

Design Principle 4: The multimedia student activities are intended to actively engage students, requiring active versus passive information processing.

In contrast to the more passive experience of watching Reading Rainbow videos, the multimedia student activities require the students to actively respond. Extensive use was made of "point and click" and "drag and drop" mouse techniques instead of keyboarding. The development team also felt it was important to provide the student with choices, so they could select different activities or examples depending on their interest.

Design Principle 5: Assessment activities must be correlated with state standards.

This principle is grounded in the realities of classroom practice, rather than any theories of learning. State, rather than national, standards have become the benchmark for measuring student progress at the local level. All assessment activities were correlated with standards from the states participating in the project, and the standards became the basis of reporting the results for teachers.. It was clear from talking with educators from the states involved in the project that unless the materials were correlated with state standards they would not be used.

Project Materials and Timetable:

The instructional web materials can be found at http://bridgesprojectonline.org. The Bridges project involved numerous media products, available in multiple formats, but this paper focuses on the student interactive/assessment activities and assessment tools available via the web. The multimedia student materials were based around the topics covered in the Reading Rainbow video programs. These interactive activities form the basis of the assessment.

This project began fall, 2001 and is scheduled for completion June 30, 2003. The major phases of the project are outlined below:

Phase I involved building the prototype student assessment activities and computer tracking process (fall, 2001). This process was a collaboration between instructional designers, multimedia producers, software engineers, and assessment experts. The design principles outlined above were central to discussions and the resulting products. The project was developed using Free/OpenSource software, using MySQL for the database, PHP for the scripting language to allow dynamic web pages, and Perl for the teacher calculations and initial teacher registration.

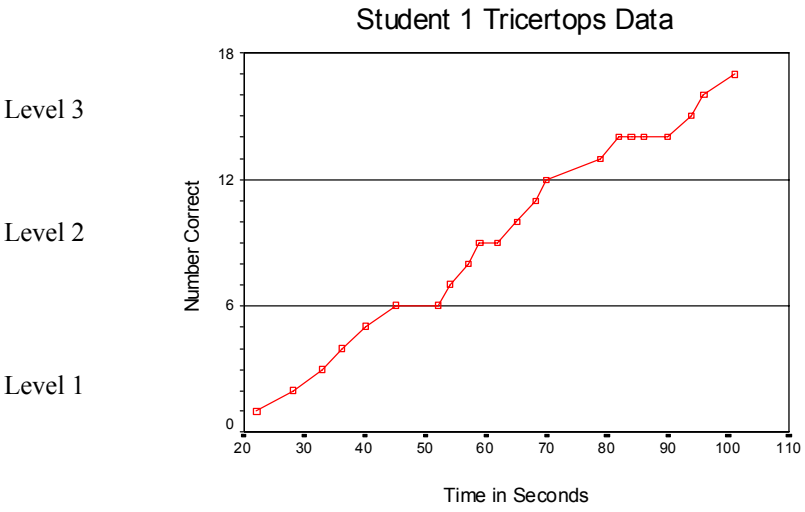
One of the unique challenges of the software development was real-time capture of student responses and development of a generic structure to allow a variety of assessment variables to be tracked. Each student input was categorized as a response, early quit, or request for help and time stamped. Responses were judged correct or incorrect. The drag and drop technology required identifying the difference between student placement of an icon and the correct placement and judging the difference against a tolerance factor. Following principles of gaming theory, arrays of manipulatives were often randomized to provide variety and limit the use of pure memorization problem solving strategies.

One of the first assessment tools developed was the student log-in. It became clear to the development team that the traditional approach of a text-based log-in was not going to work with pre-literate children. Recognizing that these younger children have limited experience with letter recognition and keyboarding, it was decided to assign children easily remembered picture codes. Each student was assigned a code consisting of two pictures.

Because we wanted to track students according to certain demographics, the log-in also required the student to identify their state and school. Again, using Flash, simple graphics were developed to guide the process.

Phase II involved testing the prototype materials in a laboratory environment (early spring, 2002). Recognizing the many intervening variables present in the classroom , a small number of children went through the prototype materials in a University lab specially equipped for testing computer software. Researchers observed students working with the materials and solicited their reactions. This testing isolated problems and provided sample data for developing tabular and graphical ways of depicting the results. The goal was to provide user friendly teacher reports of individual student and class results.

The assessment system was also developed to provide data that could be used by the developers and researchers. By tracking every mouse click researchers can develop learning curves for individual students, isolate particular instructional problem areas, analyze student responses by various demographic variables, determine instructional paths/sequences chosen by individual students, and determine places where students consistently quit an activity. Data is converted into SPSS for statistical manipulation. The graph below represents a second grader's progress through one activity; cumulative number correct is graphed with time to provide visual depiction of a learning curve.



Phase III involved a rollout of the materials to teachers and students in three states (spring, 2001). This phase involved solicitation of student and teacher reactions, as well as class observations and analysis of the assessment data collected from one class in each of the three participating states. Data was collected by an external evaluator (Media Management Services) and NCITE. Classes participating in the assessment represented kindergarten, first, and fourth grade.

Phase IV was the development of an assessment management system allowing teachers to input their students into an assessment database and receive randomly generated picture codes for their students. During early testing, teachers sent e-mail lists of their classes to the project director, who manually entered the names in the computer-based system and assigned picture codes. As the number of teachers grew, however, this procedure clearly became too laborious. Using the assessment system, teachers can delete students, edit students, and delete complete classes. The computer also randomly assigns student picture codes and provides the codes to the teacher in a form she/he can easily reproduce for distribution to the students.

Phase V is currently in progress and involves 480 teachers in nine states utilizing the materials, with twenty projected for participation in the assessment process.

Results

Observational data, teacher reports, and students' comments from Phases II and III showed that the interactive activities were very valuable in engaging students, particularly due to their game-like activities (MMS, 2002). Open-ended comments from teachers cited interactivity and student-directed learning as positives:

- "Kids really enjoy computers and they could choose different activities."
- "They loved being able to control their learning process by selecting the areas they wanted to study."
- "The more fun you can make learning, the longer the students will be actively engaged. The Bridges technologies help that to happen."

Comments from students clearly revealed that they responded to the instructional activities positively because of their game-like qualities:

- "I like it because I like all the games."
- Fossil puzzle is a fun game. Level 3 is the hardest but I can still beat it."

Data from the assessments showed that students successfully completed the materials—although there were differences according to grade level and difficulty of the activity. Not surprisingly, older children

(third and fourth graders) more successfully completed activities than kindergartners. Kindergartners tended to "early quit" activities that were more complex (required more responses and had less scaffolding) than did third and fourth graders. They also took advantage of "hints" and optional explanations more often than the older students. The percentage of correct responses also varied by grade; fourth graders performed the best, followed by third graders, and then kindergartners. It appears that the knowledge base and developmental level of the student are determinants in how well they perform. It should be cautioned that these results were obtained from a small number of students and should be interpreted with caution. The data does suggest trends, however, that will be examined more thoroughly in the testing currently underway.

Results from the pilot testing showed that on-line assessment can be an efficient way to provide the teacher with feedback about class and individual progress. The computer can easily assemble and score responses, allowing the teacher to concentrate on working with individual students:

- "Great way to make sure your children were actually completing the activities and doing them well. Showed which activities needed to be looked at more closely."
- "It's nice to have the results immediately."

Current testing will concentrate more explicitly on eliciting teacher reactions to the performance data provided, as well as their perceptions of the assessment tools themselves.

Observations of the classes isolated several interesting (and sometimes unexpected) results, which were often confirmed by teacher comments. Younger students could not enter the URL for the Bridges project (http://bridgesprojectonline.org) without help. Not surprisingly, teachers participating in the project bookmarked the site, had the students reference the history file from the address bar, or had the correct URL displaying when the children began the activity.

Reaction to the log-in, featuring picture codes, was positive. The children had no problem following the log-in process requiring identification of their state, school, and teacher. The clear graphic presentation was easily comprehended. Teachers reported that a one-time explanation and demonstration of the log-in was all that was needed and that students had never forgotten their picture codes for this site, whereas they had difficulty remembering their login/passcode for other sites. Children were excited to see their state and school on the log-in. They realized they were part of a larger project and had a sense of pride that their school was included. Interestingly, although the codes were randomly assigned, students immediately began to look for patterns. Their assumption was that the pictures somehow represented means of grouping the students.

Observational data also revealed that some students were not familiar watching video on a computer. They had no idea of the buttons/control of Real Media. They had no idea how to pause the video or what to do when the video stopped. Until video displayed via computer technology becomes more common, students will need prompting on how to control the presentation.

The Bridges web site was developed with separate sections for students, parents, and teachers, but was designed so that these individual audiences could explore all sections. There was some discussion as to whether this procedure was a good idea—that students might spend time on irrelevant material and not attend to the appropriate instruction. Observations of students showed that some did indeed initially gravitate to the "teacher" sections of the web site. Once they found "boring" material, however, they immediately accessed the student section.

Another observation was that students were constantly monitoring their classmates' activity to see if someone had found an exciting activity they might want to try. Left to navigate the web site on their own, they wanted to be sure that they did not miss anything of interest.

Summary and Future Directions:

Initial results from the Bridges project provide evidence that interactive, multimedia instructional activities can be used successfully with early elementary students—both maintaining their interest and increasing their learning. Students respond positively to multimedia instruction that is visually compelling, clearly

explained through narration (audio), and actively engaging. Results also show that on-line assessment can be successfully used with this audience, providing valuable feedback to the teacher on student's progress towards particular state standards. Testing with teachers and students to be completed spring, 2003 should provide a larger sample to substantiate effectiveness. The insight gained by this project leads to the need for additional capabilities such as dynamically adapting the instructional presentation based on student characteristics and progress. In considering this challenge, intelligent agent and tutoring technology may be useful, and NCITE is currently experimenting with prototype development of instruction involving intelligent agents. In addition to employing computer software engineering techniques to improve how we can present instruction, there is also a continuing need to define more precisely the unique blend of multimedia pictorial and linguistic elements, used singly or in combination, to promote learning in early elementary children.

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