Feature

Selecting Curriculum-Based Software

Valuable educational software can help students rise to the challenge of standardized testing and assessment.

The standards movement seeks to identify what students should know and be able to do. Since publication of *A Nation at Risk* (National Commission for Excellence in Education, 1983), state after state has implemented standardized proficiency testing as one way to hold schools accountable for students reaching standards. Also at the national forefront is technology use for individual and group work to help students process information and perform calculations to investigate and solve problems. According to Van Horn (1997), many parents, administrators, and school board members firmly believe computers are in schools to improve achievement test scores.

Software specific to the purposes of basic skills achievement, availability of computers, teacher training and involvement in implementation decisions, positive student and teacher attitudes toward computers, and time spent using software lead to achievement gains. Drill-and-practice software can make a difference in achievement and may lead to even greater achievement when combined with newer technologies that focus on constructivist and higher-order thinking skills applications (Mann, Shakeshaft, Becker, & Kottkamp, 1999).

By Patricia Deubel

Subject: All

Grade Level: K–12 (Ages 5–18)

Audience: Teachers, technology coordinators

Technology: Educational software

Software that can lead to achievement gains when used regularly to individualize instruction has a price tag, however. According to Soloway (1998), by and large, schools use only software that comes bundled with computer purchases (e.g., a word processor, a spreadsheet, a drawing program). The situation is not acceptable because software is a key component if technology is to really affect the education of all children. The right software could genuinely afford them the opportunity to engage deeply and substantively in ideas and collaborations.

Selecting appropriate curriculum-based software can be problematic for teachers because much instructional software is of limited curricular scope and addresses only low levels of learning outcomes. An appealing user interface may mask poor curricular value. Proficiency tests measure more than basic skills mastery and require students to develop problem-solving and critical-thinking skills in a constructivist environment. Fortunately, curriculum-based software has been developed that moves beyond drill and practice to include concept-building tutorials, real-life problem-solving applications, and appropriate simulations and games, all designed to support intense student motivation to learn. Management and assessment features enable teachers to individualize instruction and help students master standards that appear on state proficiency tests. (See Need Connections to State and National Standards and Curriculum Resources? to the right.)

In reference to proficiency improvement, Riel (“NECC,” 1999) said the lower the initial scores, the more effective technology is in raising test scores. Rarely does the introduction of information and communication technology into the classroom have the effect of decreasing test scores.

Advanced technologies such as multimedia lessons must be an integral part of a course, however, to achieve maximum effect on students. The one-day-per-week compromise between not requiring computers and requiring them all the time does not work (Usiskin, 1993), a conclusion supported by my recent survey. Data from 113 responding teachers (88%, sample size N = 128) from 35 middle schools in 13 Ohio urban school districts were analyzed (Deubel, 2000, 2001). This study, supported by the Ohio Department of Education Urban Schools Initiative, examined the use and effectiveness of software to help students pass Ohio’s standardized test. Software quality was a significant factor affecting teachers' decisions to use technology in their instruction.

Teachers clearly pointed out the need for drill-and-practice software for students who were failing the proficiency test because they lacked basic skills. Unfortunately, as Hirsch (1999) noted, drill and practice has a negative connotation as a tool to teach skills and runs contrary to the discovery learning and project movement. Drill and practice should not be slighted, however, because it is just as essential to complex intellectual performance as it is to the virtuoso violinist or the athlete on the playing field.

Guidelines

This article presents guidelines to judge the instructional and technical merit of curriculum-based software, which are based on my research and teachers' views about software they used. According to Peters (2000), we should be helping all teachers identify and use high-quality materials to harness the power of educational technology on behalf of the standards movement. These guidelines should help K–12 technology coordinators, curriculum directors, administrators, and teachers.

Does the software have stated learning objectives that are adhered to? Ideally, valuable software would address objectives that help students master basic skills and foster higher-level thinking skills. Check that reward systems are tied to learning events. For example, Soloway and Norris (1998) criticized Math Blaster because students get to play a shoot-'em-up game as a reward for success that has nothing to do with what they just learned. (*Editor's note:* Find software information under Resources at the end of the article.)

Need Connections to State and National Standards and Curriculum Resources?

In a national survey by *Education Week* (1999), only 12% of teachers reported that their state or district provided lists of software titles that match curriculum standards. The pressure to satisfy curriculum requirements, particularly in states with specific academic standards and high stakes tests, adds to the difficulty of finding appropriate digital content. Unfortunately, many teachers do not know where to turn to find out which digital content is aligned with their curricula, and they do not have the time or expertise to do so (Fatemi, 1999).

Software that has been correlated with national and state standards and learning objectives for the proficiency test students will take reduces teachers' time to identify and select valuable software. Some software can be excellent, however, even if no one has correlated it to a set of standards.

Software companies (e.g., The Learning Company; Lindy Enterprises, Inc.; Riverdeep Interactive Learning; Sunburst Technology Corporation) often place information about correlation to state and national standards in product descriptions and make them available to customers on request. For example, Academic Skills Assessment Preparation Software correlates with most state-mandated test specifications including ITBS, TAAS, LEAP, SAT, Florida's Sunshine State Standards, HSCT, Ohio Proficiency Tests, and more. The program prepares students in Grades 3–12 for state- and district-mandated standardized testing in the major subject areas using software that diagnoses individual student needs.

The National Education Association has developed an audit tool that is designed to help states implement standards-based reform. These Web sites provide additional information about state and national standards and contain software resources of highest quality:

Achieve, Inc.: achieve.org
Blue Web'N: www.kn.pacbell.com/wired/bluewebn/
Eisenhower National Clearinghouse (K–12 math and science): www.enc.org/resources/
ExplorAsource: www.explorasource.com
Mathematically Correct: www.mathematicallycorrect.com
The National Education Association: www.nea.org/publiced/standards/audit.doc
Only the Best 1999–2000: The Guide to the Highest-rated Educational Software and Multimedia, edited by Jamie Sawatzky, available from the Association for Supervision and Curriculum Development: www.ascd.org
Putnum Valley Developing Educational Standards: http://putnamvalleyschools.org/Standards.html
Thomas B. Fordham Foundation: www.channel1.com/users/Hudson/topics/standards.html

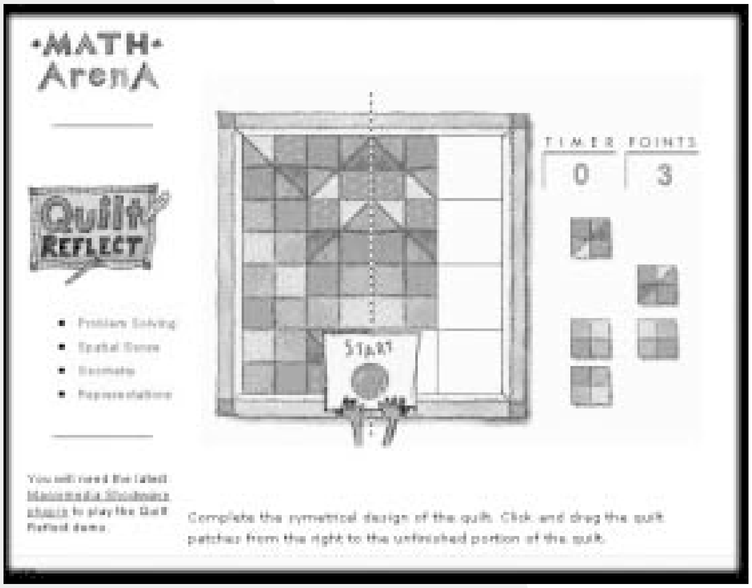

Figure 1. Math Arena provides a fast-paced and highly interactive learning experience.

Figure 2. Select learning modules in SkillsBank4 three different ways.

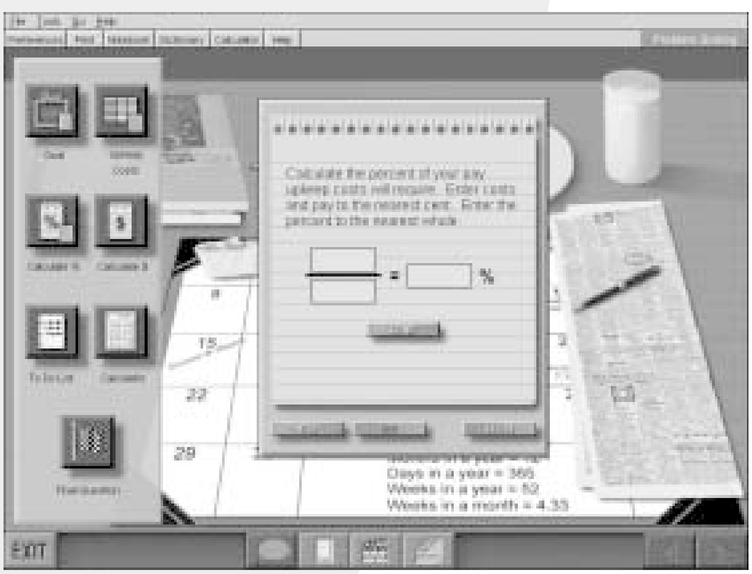

Figure 3. Plato Learning System offers practical applications.

Look for assessment summaries that clearly state which objectives students have yet to master. Software might provide additional practice on those concepts. According to Walters (2001), Riverdeep's Director of Assessment Products, Riverdeep Interactive Learning uses assessment for mastery rather than for accountability alone. Test scores are embedded in an overall system that is diagnostic and prescriptive. Students work through a coordinated system of curriculum and assessment, improving continuously, until they have mastered required skills and concepts.

Is the software motivating to students? Both teachers and students should preview software. Some teachers in my study found software too difficult and unsuitable for the ability levels of students with special needs. As a result, students quickly became bored and said they did not understand the software. Middle and high school students want software that is educational, entertaining, and fast (Tammen & Brock, 1997). One middle school administrator I interviewed was concerned about the inability of the educational software at the school to satisfy students' "Gameboy" expectations. Consequently, he believed the school was not having much success with software for proficiency intervention.

Math Arena (Figure 1), designed for ages 10–adult, helps resolve that concern. It was awarded the prestigious Bologna New Media Prize in the Best Educational Software category. It is a fast-action, graphic-intense, sound-filled, highly interactive program that focuses on problem solving. Students can sharpen their skills in a training center and then compete in the arena with up to three others.

As the novelty of using multimedia wears off, it becomes more important for software to contain motivation elements of the ARCS (attention, relevance, confidence, and satisfaction) model to maintain student interest. For example, the relevance of instruction may need to appear in the software as specific statements of the use of a skill or knowledge. Informing students of goals and objectives, and giving them frequent and early opportunities for success, can build confidence within the multimedia program. Embedded questions, scoring, self-checks, and practice questions are good methods for increasing confidence (Litchfield, 1993).

Mighty Math Cosmic Geometry teaches geometry concepts and skills for students in Grades 7–10. Polyhedral characters such as Dodeca, Hexa, and Icosa guide students on their exploration of Planet Geometry. Mystery Math Island, which is suitable for students in Grades 3–8, provides motivation for success by allowing students to buy tools to dig up hidden pirate treasures using their accumulated gold from solving equations and story problems.

Does the software allow for individualized instruction? Individualized instruction, which is also found in Math Concepts and Skills SuccessMaker and Skillsbank4 (Figure 2), supports the two most important conditions for active mental engagement: the intensity of motivation to learn and the quality of the instructional support for learning. Unlike standardized approaches to learning that hold time constant and allow achievement to vary, customized instructional processes permit students to work on standards until they are met (Reigeluth, 1997). For example, in SkillsBank4, learners can select their own lessons, teachers can specify an exact sequence of lessons, or computer diagnostic tests can determine strengths and weaknesses, and then create customized, prescriptive lesson assignments for students.

Look for extensive help features so that students can work independently with software. Cognitive help features might include tutorials, hints, sample problems, reference libraries, on-screen calculators, and glossaries. Help might also include search capabilities and clearly visible, easily retrievable instructions on how to use the software and how to recover from errors. Software that has more than one entry level and more than one level of difficulty permits students to work on only those content modules they need and those at their skill level, whether it is practicing basic skills or developing critical-thinking skills at an applications level.

For example, in addition to correlating with National Council of Teachers of Mathematics (2000) standards, the help section in Carmen Sandiego Math Detective includes a glossary of math terms and math strategies for skill-building exercises and for solving challenging word problems. This program, with its customizable lessons and on-screen progress tracking reports, is also highly motivational for students in Grades 3–7 as they attempt to save Mount Everest, the Great Wall of China, and other landmarks from Carmen's menacing machine.

Does the software suggest paths to improve and have the ability to automatically adjust for student needs? Students can develop independent and reflective thinking and learning skills if software incorporates scaffolding features. Look for guiding, coaching, and modeling messages such as *Stop reminding me* or *Show me an example*. It might contain scaffolding that is like training wheels on a bicycle. For example, defaults would enable novice learners to use only the simplest tools available. More advanced features would be revealed as learners gain expertise. Learners would control turning on or off more advanced features that were previously hidden with computer assistance in decision making (Jackson, Krajcik, & Soloway, 1998).

The difficulty level in Math for the Real World continually adjusts to the student's skill level for motivation and challenge. One teacher in my study said students just love it. Rather than displaying its more than 4,000 word problems in a textbook fashion, students play a game that includes real-life decision-making situations as members of a band touring the United States.

Does the software provide clear examples of skills that it is designed to develop? Check how software helps learners build conceptual understanding of problem-solving processes. Is there a balance between drill and practice, computation, factual recall, and open-ended problem-solving processes that explore higher-level concepts? A tutorial in Math Concepts and Skills SuccessMaker, for example, presents instruction, examples, and help to work exercises. SuccessMaker contains 1,500 learning objectives for K–8 mathematics that also promote use of higher-order thinking skills.

Applications also might include screens that summarize the major aspects presented about a topic before moving on to a new topic. This is important because proficiency tests often contain a balance of multiple choice questions and constructive response that test not only facts and basic knowledge but also the application of knowledge to problem solving.

Does the software provide some repetition to assist in retention? Retention is enhanced if concepts and core processes contained in standards are chunked together for mastery with specific facts and skills clustered under those larger ideas. Multimedia can provide two ways for learners to rehearse information. For a simple rote repetition, text is accompanied by a voice-over repeating the text to be learned. Information can be rehearsed more elaborately if learners can enter alphanumeric responses to exercises that require them to apply knowledge in an appropriate context (Vilamil-Casanova & Molina, 1996), such as found in Plato Learning System (Figure 3**)**.

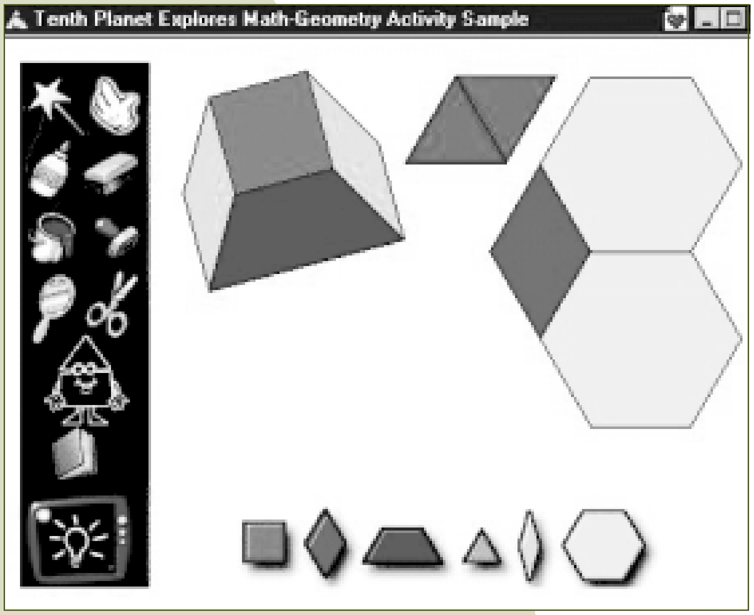

Figure 4. Students can manipulate objects in Tenth Planet Explores Math.

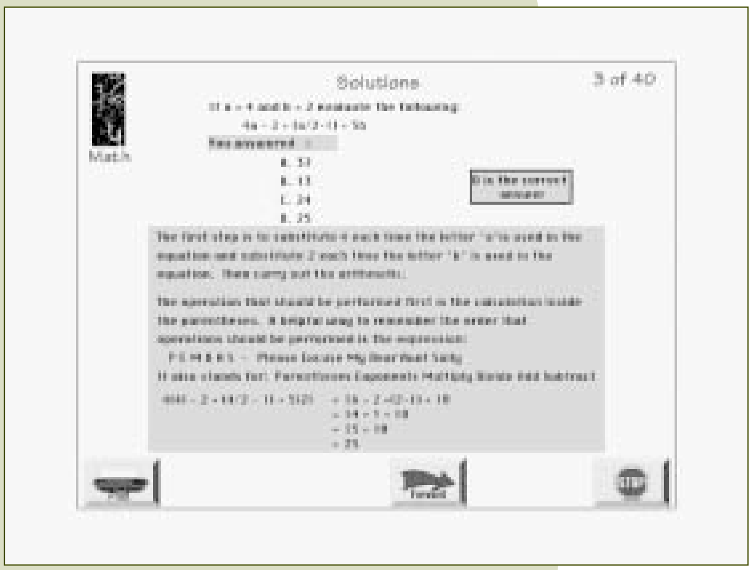

Figure 5. Optimum provides detailed feedback.

Practice exercises should be done after presenting a subject to reinforce learning by transferring the information from working memory to long-term memory. Sometimes a gap between a question and its related content will force learners to mentally search for and review information, a process that enhances retention (Thibodeau, 1997).

Do problems make reference to real-life applications? To increase transfer, knowledge should be anchored in realistic contexts and settings, as found in Hot Dog Stand. Students run a concession stand at a football stadium and try to maximize profits over an eight-game season.

Does the software accommodate more than one solution method? Only 5% of surveyed teachers who used software in their instruction indicated that their software accommodated multiple approaches to solutions (Deubel, 2000). Teachers should judge the merit of this option based on whether their students are novice or advanced learners. According to Tergan (1997), there is high probability with multiple representations that at least one of them will be misunderstood. This could hamper an overall understanding of the material, particularly for novice students. Only advanced learners with a high level of domain knowledge and metacognitive competence may benefit from multiple representations.

Multiple approaches to problem solving are included in the Tenth Planet Explores Math modules. These modules allow students to manipulate objects (Figure 4 was created using the geometry module, Creating Patterns from Shapes) and keep computer journals of investigations, and the modules provide multiple linked representations. Problem difficulty changes based on whether students are novice or advanced learners.

Is feedback tutorial in nature, or does feedback just indicate responses are right or wrong? Feedback should provide occasional motivational messages, as well as information about the correctness and/or appropriateness of a response, as illustrated in Figure 5 taken from Optimum. It should be on the same screen with the question and student response to reduce the memory load on students, should provide hints, ask students to try again if answers are incorrect, and be tailored to the response. Feedback should not encourage students to answer incorrectly just to see feedback (Orr, Golas, & Yao, 1994). Users should not be trapped in a failure cycle, however. After two attempts, the program should provide the correct response and indicate why an answer was wrong. Rewards for a correct response, such as praise, award ribbons, or animation, should be appropriate for the activity (Abramson, 1998).

Are help and audio features under user control? One software developer I interviewed omitted sound from the software because of distractions it might cause some students. She wondered if sound serves as reinforcement to all students. However, appropriately used sound can enhance learning because it plays a role in information processing (Bishop & Cates, 2001) and retention (Hofstetter, 1997). Its use, along with images and video, is supported in a new Universal Design for Learning (UDL), which is being developed by CAST Inc., the Council for Exceptional Children, and others. Research with UDL can be expected to show improved outcomes for all learners, including those with identified special needs (Pisha & Coyne, 2001).

The issue is that help and audio should be under learner control. Audio should be linked to the learning activities, not just provide an unrelated musical background for the sake of having sound. In a classroom setting, it may be necessary to purchase headphones.

Many students who do poorly on proficiency tests are the same ones who read poorly. Kenworthy (1993) noted that poor readers benefit from multiple media because they often get their information from television, so the mix of moving video, audio, and high-quality graphics may grab their attention in ways traditional approaches to instruction would not. Audio can explain menu choices, which can be highlighted as explained. Audio can be interrupted when learners make a selection. Audio that supports text should match the text exactly so that learners may identify unfamiliar words. Learners should be able to pause or repeat audio, as well as repeat text passages.

Additional Considerations

Software should contain a teacher management system that permits teachers to modify it to meet individual needs, match software with curriculum, keep track of student progress, and identify students' areas of weakness and strength. An extensive database of problems will provide long-term value for technology dollars spent and ensure that students encounter a different set of problems on repeated use of the software. Teachers want software to have a security system so that student errors or intentional attempts to disrupt software operation are not disruptive. They want security that also prevents student access to teacher-only information, including student data.

Students should be able to change answers before the software program grades assessments because technology testing practices should mirror paper-and-pencil practices. Look for software that also allows students to review questions that were missed. Students should be able to save data, so that if they are not finished with a lesson, they do not have to begin again. A message when data has been successfully saved will give them a sense of relief and indicate that it is clear for them to move on to other actions.

Visuals and icons should be culturally sensitive, particularly if the product is to be used in divergent cultural contexts (McFarland, 1995). Each icon should be clearly distinguishable from the next, chosen to represent accompanying text, and stand out from its background, which is particularly important for vision-impaired students. Icons and graphics should be age appropriate. Students notice the use of real people as opposed to cartoon characters and are critical of font size, use of color, and buttons that do not work (Tammen & Brock, 1997). Consistently placed navigation elements make a program easier to use, add structure, and provide learners with control over events.

The amount of information presented on a screen depends on age and grade level of learners. Illustrations should match the intended audience's cognitive perspective, because some illustrations might mean different things to different audiences. Text and visuals should complement each other, offering different yet related information to promote learning (McFarland, 1995).

Concluding Remarks

As educators, we face three challenges. With the increase in the number of instructional software products available and limited financial resources, we must eliminate the "let the buyer beware" attitude. We must adopt instructional strategies that see time as a variable and hold standards as constants. However, as I noted in the beginning of this article, our biggest challenge is to harness the power of technology for the standards movement. Hopefully, guidelines presented in this article will prove valuable for that effort.

Resources

Academic Skills Assessment Preparation Software: Wordware Publishing, Plano, TX 75074, 800.229.4949; http://wordware.com/education

Carmen Sandiego Math Detective: Brøderbund Software, The Learning Company, 500 Redwood Blvd., Novato, CA 94947; 800.825.4420; www.learningcompanyschool.com

Hot Dog Stand: The Works: Sunburst Technology Corporation, 101 Castleton St., Pleasantville, NY 10570; 800.321.7511; www.sunburst.com

Math Arena: Sunburst Technology Corporation, 101 Castleton St., Pleasantville, NY 10570; 800.321.7511; www.matharena.com

Math Blaster: Knowledge Adventure, 4100 West 190th St., Torrance, CA 90504; 800.545.7677; www.knowledgeadventure.com

Math Concepts and Skills SuccessMaker: Computer Curriculum Corporation; 800.433.3236; www.ccclearn.com/products/successmaker

Math for the Real World: Knowledge Adventure, 4100 West 190th St., Torrance, CA 90504; 800.545.7677; www.knowledgeadventure.com/press-room/product/d9030prepre003.html

Mighty Math Cosmic Geometry: Edmark Corporation, PO Box 97021, Redmond, WA 98073-9721; 800.691.2986; www.edmark.com/prod/math/cosmic

Mystery Math Island: Lawrence Productions, Inc., 1800 South 35th St., PO Box 458, Galesburg, MI 49053.0458; 800.421.4157; marketing@lpi.com; www.voyager.net/Lawrence/software/mathematics/software_mystery.html

Optimum: Photonics Graphics, 2244 Park Ave., Cincinnati, OH 45206; 888.548.4440; photonics@photonicsgraphics.com; www.optimumtest.com

PLATO Learning, Inc.: 10801 Nesbitt Ave. South, Bloomington, MN 55437; 800.447.5286; marketing@plato.com; www.plato.com

SkillsBank: SkillsBank Corp., The Learning Company, 500 Redwood Blvd., Novato, CA 94947; 800.825.4420; www.skillsbank.com

Tenth Planet Explores Math: Tenth Planet, 625 Miramontes St., Half Moon Bay, CA 94091; 800.321.7511; www.sunburst.com

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