BESTQUEST TEACHING SYSTEMS®

Algebra'scool® and *Math'scool*®

Introduction

BestQuest Teaching Systems® has developed a revolutionary means of delivering supplemental math curriculum to elementary, middle school, and high school students. This instructional advancement is delivered in a dynamic DVD format with supporting print material for teachers and students. *Algebra'scool*®is a comprehensive, standards-based Algebra 1 instructional resource. *Math'scool*® is in development and will build the conceptual foundation of topics in Numbers and Operations, Geometry and Measurement. The programs are based on a belief that all students can learn mathematics when provided with appropriate tools in a motivating environment.

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BestQuest's *Algebra'scool and Math'scool* use an entertaining animation-based framework to capture students' attention and teach basic mathematics and algebraic concepts rooted in real-world contexts. Conti et al. (1995), Koller et al. (2001), and Burkam et al. (1997) have all found that students learn better when they are intrinsically motivated to learn and personally engaged in the instructional process. Both programs relate to students on an appropriate level and through a medium that they enjoy. The technological design affords students every opportunity to become excited about and involved in their own learning. The programs engage students' senses and arouse their interest, so that they become self-motivated. Through the innovative delivery system, *Algebra'scool* and *Math'scool* lead students to success not only in learning basic mathematical concepts, but also in learning for a lifetime.

The use of original animation ensures that students will find *Algebra'scool* and *Math'scool* entertaining, but teachers will want to know that the program is comprehensive and rigorous. Due to the requirements of the No Child Left Behind (NCLB) legislation, curriculum must be built on solid instructional methodology, so that learning can be demonstrable. Mevarech and Kramarski (1997) and Brenner et al. (1997) have found that, in order to achieve such learning, students must be presented with curriculum that includes multiple representations, relevant problem-solving, and continuous feedback. BestQuest focuses instruction on foundational topics in Numbers and Operations, Geometry, Measurement, Data Analysis, and Algebra 1 in order to promote student understanding of essential concepts common to state standards and state tests. Additionally, it provides numerous opportunities for students to practice hands-on and cooperative learning in a multimedia environment designed to engage students of diverse learning styles and abilities. Blankenship and Dansereau (2000) and Blinn (1989) argue that animation is an effective instructional tool because it helps direct attention. Proctor et al. (1992) and Goldman et al. (1999) find that entertainment is an effective educational tool as long as content is kept at the center of the lesson. During the development of *Algebra'scool,* BestQuest ensured that lessons were built around solid content by collaborating with experts who knew how to reach students and engage their attention, while the educators at BestQuest maintained their focus on teaching Algebra 1 in a way that would prepare students for classroom and lifetime success using mathematics. In the development of *Math'scool*, the same process is being followed with improvements and additional features being implemented based upon the suggestions and feedback from classroom teachers using *Algebra'scool.* Through the instructional variety, high standards, and focused lessons both programs present mathematics in a way that will ensure educators that their students are being adequately prepared for success according to any measure of academic achievement.

The DVD-based delivery of the mathematics curriculum provides state-of-the-art instructional facility through innovative multimedia integration. In collaboration with leading technology and education/entertainment companies, BestQuest continues to strive to produce the most effective digital products available. ComChoice, a leading digital media production house, designs and produces the digital files. RubberBug, an innovative character animation studio, produces the character animations. YMS Consulting, a product design and marketing firm specializing in the youth market, focused the design of the cartoon content of both programs to ensure that they are appropriate for its pre-adolescent and adolescent audiences. BestQuest designs the instruction to make effective use of multimedia and then collaborates with these partners to ensure that the strong content is enhanced by Hollywood-style production values and professional resources. Withrow (1997) claims that DVD technology provides a new way of communicating that may change the educational landscape due to its convenience and instructional facility. But as powerful as the format is, it must be utilized in a way that is content-rich, appealing to students, and intuitive for teachers. Therefore, BestQuest collaborates with the highest quality of partners to ensure that the program's entertaining approach appeals to students and the classroom ease-of-use provides teachers with effective and convenient teaching tools.

The program requires only a television connected to a DVD player. Nonlinear access enables educators to develop their own paths of instruction, while frequent auto-pauses afford educators complete control over navigation and pacing. The advantage of having video imaging superior to that of VHS imaging is enhanced by the fact that DVDs are more durable, portable, and easy to store than alternate formats. Resources and activities are provided for hands-on, real-world problem-solving, such as manipulative-based projects. Whole-class instruction and individualized instruction and review are facilitated through the multiple points of entry for lessons in the program. All of these features are designed for the dual purposes of engaging students and facilitating instruction with intuitive, easy-to-use resources.

BestQuest developed *Algebra'scool* and is developing *Math'scool* to answer an unmet need in the math education market. Because students are held accountable for their academic performance under NCLB, the company envisions programs that will appeal to *all* students, including those not traditionally reached in the classroom. BestQuest realizes that middle and high school students are the driving force behind the recent explosion of animated programming in popular culture. The company believes that the appeal of animation in the youth-oriented entertainment industry can be replicated in the education market. BestQuest's goal is to build delivery tools that will incorporate the best instructional methodology even as it motivates students to enjoy math class through the presentation of content in an irreverent, engaging fashion.

This white paper outlines the research basis on which BestQuest developed *Algebra'scool* and is developing *Math'scool*. It provides details of the scientific basis for the format and content of BestQuest's programs to satisfy NCLB-based inquiries into the nature and validity of curriculum used in the K–12 market.

Student Motivation and Real-World Relevance

Why do some students succeed in math while others do not? Davenport et al. (1998) study the National Assessment of Educational Progress (NAEP) transcript data to determine the number of courses taken by high school students to satisfy curriculum requirements. They looked at seven different categories of math curriculum, and find that Algebra 1 is a part of the sequence taken by more than 50 percent of high school students to satisfy graduation requirements. It is critical, therefore, that all students are given every opportunity to succeed in the course. However, Davenport et al. found that, though there are few differences in the *number* of courses taken by students, minority students and females are inclined to take a different *kind* of math course. Specifically, they take less Algebra 1 and the higher math courses that follow Algebra 1. Instead, they rely on General Math courses to complete their coursework. This is true, even in those cases where students are fully capable of doing coursework beyond Algebra 1. Burkam et al. (1997) make a similar finding in science education, pointing out that students often do not take higher courses, relying on courses that meet the minimal requirements for a degree. This led BestQuest to ask why students do not challenge themselves to go further in math education.

Marsh and Yeung (1998) conducted a longitudinal analysis of school grades, academic self-concept, course selection, and standardized test scores from the same sample, the NAEP, to determine how female students, for example, are effected by their choice of math coursework and how this in turn affects their performance in class. They find that no matter the math courses that students take, female students had lower math self-concepts. This was even true in cases where females actually had better math scores than their male counterparts. Additionally, the researchers found that a cycle exists in which students who think poorly of themselves in a math context eventually begin to perform poorly, which leads to newer and lower self-assessments. This finding is paralleled by a study by Gohm et al. (1998). They studied two groups of students, one who were spacially gifted and another who were mathematically gifted. They compared test scores, among a range of other variables, and found that even students who are spatially "gifted" may do poorly in math class because they do not believe themselves to have the necessary capability to succeed. Relative to the mathematically gifted students, who saw themselves positively in terms of their ability to do math, the spacially gifted students were not performing up to their academic potential. The researchers surmise that much of the reason is that the spacially gifted students have a low opinion of their abilities in math.

This research shows two important facts: 1) It is crucial that students be given the opportunity to succeed in Algebra 1, so that they will go on to take higher math courses; 2) If they are to succeed in Algebra 1, they must be given opportunities to relate to the content in a way that makes them feel comfortable and secure in their abilities and their understanding of the materials. The research points out that students will not succeed or go on to future math success if they are not given opportunities to build self-confidence in a learning environment that reflects their own interests. *Math'scool* is being designed to provide the mathematical foundations necessary for success in algebra and in other higher-level math courses.

Research shows that underachievement among some student populations is attributable to the failures of a traditional delivery of curriculum. With the right kind of curriculum and delivery, all students can learn math. Mevarech and Kramarski (1997) considered two studies of seventh grade math students. The first was a study that analyzed how students process information. The second looked at students' academic progress over an entire year. Weighing the findings of the two studies in terms of a framework designed to measure social cognition and metacognition, the researchers found that students performed best when teachers used a process devised of several important steps: Introducing the new concepts, Metacognitive questioning, Practicing, Reviewing and Reducing Difficulties, Obtaining mastery, Verification, and Enrichment (or "IMPROVE" in the research construct). This research pointed out that with a multidimensional approach utilizing metacognitive questioning, peer interaction, and feedback enrichment processes, students of any ability can succeed in math coursework.

Brenner et al. (1997) found that students of all skill levels and learning styles have been shown to succeed with a curriculum delivery that recalls meaningful contexts, utilizes multiple representations to explain concepts, and incorporates problem-solving and cooperative learning. Specifically, students who learned functions through the use of these three reform-oriented teaching methods performed better in post-tests than those who learned under traditional means. This was true even for English as a Second Language (ESL) students. These findings are in line with the reform suggestions of the National Council of Teachers of Mathematics (NCTM, 2000). In its 2000 Update to the National Standards, the NCTM outlined the ideal curriculum as follows:

> The curriculum is mathematically rich, offering students opportunities to learn important mathematical concepts and procedures with understanding. Technology is an essential component of the environment. Students confidently engage in complex mathematical tasks chosen carefully by teachers. They draw on knowledge from a wide variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress. Teachers help students make, refine, and explore conjectures on the basis of evidence and use a variety of reasoning and proof techniques to confirm or disprove those conjectures. (p. 3)

Such a curriculum design departs from the traditional cycle of definition, example, and pencil-and-paper drill. Defining the lesson in terms of real-world problems that students can understand is key, according to the research. Fuchs et al. (1997) studied 40 classrooms using one of three randomly-assigned methods: 1) task-focused goals, 2) self-referenced assessment feedback, and 3) contrasting or miscellaneous goals. They measured each group's performance along a range of variables including variety and difficulty of problem choices, understanding, effort, and motivation. They found that students, who were being taught using task-focused goals, chose more interesting and challenging problems, enjoyed math more, were more self-motivated, and tried harder to succeed. Specifically, for low-performing students, those with task-focused goals as a teaching tool were more likely to increase academic performance.

Why does real-world problem solving play an important role in the learning process? One possible reason is that students taught through problem solving interact and participate in class because they are motivated, and consequently they have their weaknesses and strengths identified earlier so interventions may occur. Mevarech and Kramarski (1997) and Brenner et al. (1997) point to the importance of feedback in the learning process. Corrective measures can only be taken once assessments have been made, and these occur readily through problem-solving participation.

Problem-solving is important because students are more motivated to solve problems they relate to in their everyday lives than they are to learn and apply a dry academic formula. Students who are motivated and engaged have been shown to take more courses and do better in math and science courses than those who are not. (Conti et al., 1995; Koller et al., 2001; Davenport et al., 1998; Burkam et al., 1997). Koller et al. (2000), in an article titled "Does interest matter? The relationship between academic interest and achievement in mathematics," argue that from grade 7 to grade 12, the impact of motivation on a student's course choice and academic performance becomes more pronounced. Similar to the research by Marsh and Yeung (1998) regarding academic self-concept, this research found a cycle evident, in which those who are motivated in math do well, which motivates them even more, while those who don't enjoy math go in exactly the opposite direction. Burkam et al. (1997) conducted a longitudinal analysis of 10th grade students' science performance. They found that when female students are actively involved in learning (such as in laboratory experiences) they perform better than when they are placed in a learning environment where they are expected to memorize and recite.

The need to inspire students so they enjoy learning math is a chief factor that led BestQuest to utilize the animation format for presenting mathematics concepts. BestQuest's *Algebra'scool and Math'scool* utilize a high-interest format to engage students in ways in which they have not been engaged before. Not only do the programs utilize multiple representations and problem solving, they do so within the contexts of students' everyday lives through the interactions of the characters. Each character is modeled on a specific set of common pre-adolescent and adolescent traits so students can relate to him or her. These traits and the problems the characters face in the animations were defined and reviewed through a collaboration with YMS Consulting, a company devoted to understanding youth in today's market and designing products and programs appropriate to them. The President of YMS Consulting, Dr. Dan Acuff has a specialized expertise in defining products that will appeal to youth of middle and high school ages, expressed in his book *What Kids Buy and Why - The Psychology of Marketing to Kids* (The Free Press, a Division of Simon & Schuster, 1997). Through the guidance of his company's innovative Product Matrix Model, BestQuest was able to define character archetypes, humor types, and design elements for the characters and animations that reflect the everyday lives and personalities of today's students.

Through the combined effects of concept delivery and engaging storylines, *Algebra'scool and Math'scool* motivate students to learn math as they follow the characters through a series of adventures and misadventures. They encourage students to utilize creative thinking—a concept critical to the students' appreciation of math because they incorporate both motivation and comprehension. Jalongo (2003) claims that in order to utilize creative thought and imagination as a learning tool, teachers should note the following:

> If we seek to prepare children for the future, we must devote attention to the thoughtful critique of creative products in society. We also must think beyond what is customary, orthodox, and

> conventional if the genuinely important potential of creativity—the ways in which it is used to capture the very essence of its culture—is to be realized.

The unconventional delivery system of BestQuest's programs is intended to serve the needs and interests of all students. Through using the program, even students who have been accustomed to turning their thinking off when they walk into math class will be challenged.

Technology and Math Education

Iris Carl, former president of NCTM, writes in *Electronic Learning* that technology is critical to mathematics education because it can "furnish an inexhaustible source of new mathematical questions about real world situations for students to explore" (1993, p. 60). Math teachers were among the first in the education community to embrace technology as both a delivery system and an aid to study. This is due to research that has shown computers to support different learning styles by engaging more of a student's skills than traditional methods. Wang et al. (2001) argue that computers can be used to reach a broader student population because more diverse learning styles are used in an environment where technology plays a vital role.

Cohen (2001) argues, more to the point, that a technology-rich environment works especially well with ninth-grade students in math class because it engages students with various learning styles in ways they can readily understand and relate to due to the role technology plays in their everyday lives. Technology, according to Cohen, can be readily used for problem-solving and collaborative learning, and therefore adds to the learning experience in an environment that makes use of other effective teaching methods.

Technology is promising in its various delivery systems because it can store so much, and consequently it has examples and tutorials at the ready to answer any student request (Carl, 1993). It is also "patient" as a tutor, as it will respond to a student as many times as the student chooses to ask, so that the student learns the concept at his or her own pace (Lynch et al., 1995).

Mann et al. (1999) studied the case of West Virginia, which began in 1990 implementing computer technology and training in all schools in the state. The state provided software and hardware, and the schools had the option to put computers in the classroom or in a computer lab. Two findings were relevant: 1) The more computers were used, the better the students' overall academic achievement rose; 2) The ready use of computers in the classroom was preferable to the structured use of computers in a lab. This showed that technology helps bring about academic success, and the closer technology is at hand, presumably being used more often, the better the results are. The researchers claim that 11% of the deviation among West Virginia schools on standardized tests was due to the use made of technology. They also argued that improvements in academic learning achieved through implementing technology are more cost-effective than those arrived at through other reforms, such as class-size reduction.

Does all this sound too good to be true? Well, technology does have its drawbacks. One of the strongest points of concern identified in the research literature is that technology as a delivery system can become an end in itself (Goldman et al., 1999). Without adequate attention to content, both curriculum developers and educators can become enamored with the fun and excitement that technology brings into the classroom and forget that a lesson has to be conducted. Students can get caught up in working a mouse button and forget what the point of the lesson should be. Teachers can involve themselves so much in developing a problem with technological flourishes that they forget to solve the problem and close the loop to ensure student understanding. Wetzel et al. (1994) argue the following:

> Video production techniques that are irrelevant or detrimental might be exemplified by attention-grabbing devices using effects designed to dazzle and by related quick-paced techniques not suited to learning. . . Learning appears to be little affected by devices that temporarily draw attention – such as rapid cutting between shots, sudden noticeable changes, special visual or sound effects – or when these are included merely for general realism. . . Viewers tend to prefer edited presentations so long as they result in understandable presentations that are cut at a rate

appropriate to the complexity of the scenes and are not sustained to the point of boredom. (pp. 208-209)

The point is that technology must be used to get a point across, not just for show. Therefore, content has to be addressed as the first point of a math lesson if technology is to do its intended job as a purveyor of information.

Another concern with technology is the problem of glitches. Every teacher and student knows the frustration of not being able to get to the content of the lesson because the technology used to deliver it is malfunctioning. Sometimes this is due to improper training and setup; other times it is due to electronic problems (Ferry et al., 1996). Neither problem can be fixed on the spot with a classroom full of anxious teenagers. When such a problem occurs, the educator usually has to turn to an alternate lesson without adequate preparation and review time. This is one of the major reasons cited by those teachers who have not accepted technology's role in the classroom. They do not want to be at the mercy of a temperamental electronic tool.

BestQuest chose to build lessons on DVD because it is a user-friendly technology. It is portable, storable, durable, and affords superior image and sound quality, compared to similar technologies. Because it works with a television and a DVD player, it doesn't require large amounts of training. Lessons have auto-pauses built in so that mistakes or miscues do not ruin long blocks of classroom time. The autopauses also facilitate teaching, as natural breaks can be taken so that a concept can be reinforced. As a leading form of digital media, the DVD is coming into widespread acceptance and application in the education community as well as the community at large. Because the DVD is playable on a DVD player as well as on a computer with a DVD-ROM drive, the format affords flexibility for in-class instruction coupled with at-home work by the student (who can check out the discs and use them at home). Because minimal training is required to make the program ready for use, teacher buy-in should be greater (Ferry et al., 1996). Finally, as Withrow (1997) argues, DVD is a new technology that may ultimately prove as revolutionary as publishing was in sharing the written word. This is due to the fact that digital information has great potential for changing and enhancing the way we process data, and DVD is a lowest-common denominator application. Therefore, BestQuest offers the DVD-based program in the expectation that such technology is the future of math education, and that within a few years, the *algebra'scool* program will be a standard by which other programs are judged for ease of use and relevance of instruction.

Brain Research and the Learning Process

Much brain research has been done which focuses on brain dysfunction, but that doesn't speak to the issues of why and how most students learn. The research which *has* been done to highlight how the brain works is often hindered by the fact that different researchers focus on specific parts of the brain only. By doing so, they say little about the brain in its total complexity (Caine and Caine, 1998). The most appropriate research on brain development and its impact on math education, therefore, deals largely with younger audiences. On the whole, the research shows that a window exists in which teachers may actually positively impact the way students' brains develop by employing creative and participatory teaching methods. Sousa (1998, 2001) claims that the window of development in a child's brain is from ages 2 through 11, and that during this timeframe, a teacher should utilize music and other multi-sensory teaching tools to facilitate the development and proliferation of neural connections in students' brains that foster memory and learning. He draws conclusions from his review of the research that, even after this window has closed, teachers may impact student learning by building on prior knowledge and anchoring lessons in meaningful contexts so that students' emotions trigger chemical reactions conducive to learning. Sousa (2001) offers the following additional research findings:

1. Learning is best done in multi-sensory environments, with high interest, visual materials included.
2. Lessons should be presented in short, manageable timeframes, conducive to the attention spans of today's youth.
3. Lessons should be flexible, to allow for the natural changes in students' biorhythms.

Abbott (1998) argues that when learning takes place, the brain adapts and changes to handle new information. He concludes from this that lessons which require the student to process information in many different ways are most likely to spark learning. BestQuest's multimedia delivery of content achieves this by presenting information visually, verbally, and kinesthetically. The brain works to make connections between the parts of the brain that process each type of information. Learning is enhanced through this process. Abbott also argues that collaborative lessons and problem-solving take advantage of the way the brain naturally works and these teaching methods prepare students for the real world with relevant skills.

Some research suggests that by using music and multiple representations, the teacher is able to replicate the learning environment students underwent in earlier brain development with the goal of fostering learning even after the students' brains have, in a physiological sense, stopped "growing" (Sousa, 2001). Cardinale (1990) made a similar point when he claimed that students should be given lessons that stimulate both sides of the brain. This means, for example, that music and logic lessons, including both creative and critical thinking, should be stressed. Wetzel et al. (1994) reviews the research literature on the use of music in video production and finds that music sets the emotional tone of a scene, provides a conceptual framework upon which understanding of a piece is formulated, conveys information in its own right, and affects pacing of information processing. For all of these reasons, music is a powerful tool for use in aiding learning through framing the presentation of information.

BestQuest utilizes music and humor, as well as top-notch production values to present equations and solve problems. Word problems are taught side-by-side with multi-step formulations so that students are required to think about math in verbal as well as symbolic terms. By using a multidimensional approach, *Algebra'scool and Math'scool* encourage students to think creatively even as they learn expressions and algebraic definitions in relevant and meaningful contexts.

Animation and Content Delivery

The choice of animation as a delivery vehicle was a bold one. It was made in the belief that both middle school and high school students are receptive to a learning environment that utilizes a resource they have not normally associated with education. Because students are very familiar with animation but know it almost exclusively as an entertainment venue, BestQuest knew that it would have to understand and exploit the use of animation for teaching purposes in order to avoid being seen as having an unusual but ultimately superfluous education resource. Therefore, initial research was done to determine whether creative and entertaining venues could be appropriated with evident educational utility. Conti et al. (1995) argued that creative and engaging activities used in the classroom do, in fact, promote motivation for learning and spark creative thinking. They also found that creative activities and resources are especially conducive to the development of long-term retention of data, if utilized correctly in the classroom. This finding is in line with the argument of Proctor et al. (1992), who claim that entertainment as a tool for classroom instruction is a valid one, provided it is used ultimately to support the delivery of rigorous content.

Research shows that the efficacy of animation as a content delivery system is born out by testing in a classroom environment. Craig et al. (2002) conducted two experiments designed to test whether animations facilitated or interrupted learning. The first experiment consisted of three different presentations of the same information. In one, an animated agent spoke and continually gestured to a graphic depiction of data to direct attention. In a second, the agent appeared and spoke the same narration, but did not gesture. In a third, no agent appeared, but the same narration and graphic depiction were presented. Further, the researchers conducted research to determine whether continuous gesturing by an animated character was as effective as sudden changes in directive poses or static information. The researchers hypothesized that the animated character might distract from data and thereby hinder recall. Rather they found that the animations did not distract from understanding, and that the directive capacity of animations and flash onset data performed consistently better than static and non-animated data, Craig et al. found that animation, whether done through continuous movements, or through flash onsets of information overlaid on previous data consistently results in better recall for students than does static presentations. The effects of sound tracking, however, have been shown in other studies to slightly complicate such findings (Wetzel et al., 1994) because sound is another powerful information dissemination tool. The second experiment conducted by Craig et al. (2002) considered this. In the second case, the researchers presented information through three means: 1) voice only, 2) print only, and 3) combined voice and print. They found that the use of print materials seemed to be the least effective means of delivering information in a way that promoted recall and comprehension. Voice only presentation worked best. Voice/print was next. These findings considered print and voice-overs, and determined that sound seemed to be at least as important as visual cues. This led BestQuest to search for studies that indicated the relationship between animation and print. Since BestQuest's animation makes use of sound as well as continuous motion visual presentations, it seemed possible to prove that their animation would be superior to print in promoting understanding and recall.

Blankenship and Dansereau (2000) studied the effects of animation in relation to print in the presentation of node-links (highly developed graphic organizers that are complicated to follow and understand). They found that animation is more effective than either print alone or a print-animation mix in influencing students' recall in technical classes. Therefore, even with complicated information, animation proved itself to be useful for promoting recall and comprehension. Other research supported this finding. Hall (1996) claimed that animations used in biology classes were beneficial in their ability to reinforce student learning. Wetzel et al. reviewed the research literature and found that for pre-adult learners animation has been proven effective in all but a very few studies. They suggest that animation is useful for four reasons:

1) It helps direct attention to important information.
2) It effectively presents information.
3) It enhances practice by being more interactive than static (print) materials.
4) It has "cosmetic" appeal that engages students.

All of the studies reviewed suggest that animation, if used as the primary tool for delivering content, can be useful and beneficial for students by promoting recall of mathematics concepts. Koller et al. (2001) suggested a final reason why animation is beneficial to student learning. Students who are motivated are more likely to learn. Hall (1996), Wetzel et al. (1994), and Proctor et al. (1992) support this in their research. Therefore, it stands to reason that putting students in a classroom in which they are taught through familiar and interest-building tools will ultimately benefit them. Considering this reasoning, the bold move BestQuest made in choosing animation as a delivery system begins to look not like a risk, but rather like an idea whose time has come.

Multimedia and Curriculum Integration

Greenfield (1985) argues that print is not always the best choice for delivery of curriculum because it draws on a more narrow skill set than does multimedia. Print calls on the student to read, organize, and recall. Multimedia does this and more. In a multimedia curriculum, students also have to listen and view. The additional sensory input provides data the student has to sort and prioritize and enables the student to develop real-world skills and increased mental capacity for information processing. Additionally, Craig et al. (2002) and Blankenship and Dansereau (2000) both suggest that because print is a static medium, it does not direct students' attention to important information as effectively as either animation or an animation/print mixture does.

Mevarech and Kramarski (1997) find that in a learning environment where students are called on to process multiple information inputs, they recall information better and apply math concepts more effectively. Doerr and English (1986) claim that providing such a learning environment is especially important for adolescents, who live in a multi-sensory everyday world in which they collaborate and learn by doing. Since students are constantly processing information from numerous sources in everyday life, it makes sense to teach in this manner as well. To teach with traditional read-and-drill methods is to put the students in a too-rigid environment. Students must be given opportunities to learn math concepts in multiple formats anchored in meaningful contexts, with problem-solving and collaboration as essential environmental factors.

One way of providing multi-sensory input is to include activities involving manipulatives. Ross and Kurtz (1993) claim that there are four rules for doing this effectively.

1. There must be a choice of manipulatives.
2. There must be adequate lesson preparation.
3. There must be student participation.
4. There must be process evaluation.

According to this view, manipulatives can be a hindrance to learning if they are not used properly. They must be a delivery system for teaching the lesson and must not become an end in themselves. Just as using technology can use up valuable class time without providing much value if the lesson is not thoroughly prepared and technology's role in the lesson is not well understood (Goldman et al., 1999), so using manipulatives can be a wasted effort if they are not used efficiently in a way that furthers the point of the lesson. If they are carefully integrated into the lesson, according to the research, they provide an excellent opportunity to involve students in learning by doing, which is essential to lesson recall and comprehension (Burkam et al., 1997; Doerr and English, 1996).

Although visual media presented alone is important for student learning because it promotes bi-sensory information processing as the student listens and views (Anderson and Lorch, 1983), a combination of media and print materials is still often favored as the most effective format for presenting curriculum (Wetzel et al., 1994). This is due to the different strengths that print and visual media have as delivery tools. Fletcher (1990) found that laserdiscs were more "efficient" than print media because they allow students to process information in ways that are familiar to them, so students spend less time learning and more time applying the knowledge. Anderson and Lorch (1983) pointed out that when viewing video media, students have difficulty paying attention, just as they do when reading. The difference is they can still hear video media and process relevant information, even when they look away. Therefore, learning is made more effective because it involves a continuous engagement. However, print materials provide a static resource that students can go back to for review. Therefore, it is the integration of these fluid and static media that provide the optimal level of detail and instruction for students.

BestQuest's *Algebra'scool and Math'scool* are visual programs. By presenting information in animated sequences, the program maintains students' interest and provides an environment in which students process multi-sensory information for optimal learning. The program also utilizes student print materials for students to complete while they are viewing, so students process information and write down details to aid in recall. In addition, manipulatives are provided for kinesthetic and participatory learners. The program integrates these traditional and multi-sensory resources in cost-effective, engaging programs that teach foundational mathematics concepts in *Math'scool* and algebra concepts in *Algebra'scool*. It is a revolutionary approach for involving students in learning math in a way that students enjoy. Because the multimedia approach has been shown to be the most effective means of delivering curriculum (Wang et al., 2000; Cohen, 2001), educators can be comfortable with the program. They know their students are being adequately prepared for math success. BestQuest provides resources to the teacher so he or she is in complete control of pacing and instruction, and the teaching process can go forward in a new and exciting way. When students are engaged and excited, teachers will find themselves spending less time trying to get their students to care about math and more time explaining the role math plays in students' lives.

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