# Algebra'scool® White Paper

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**Algebra'scool is . . .**
Engaging for students
Accessible to all
Rigorous in content
Relevant to the real world
Convenient to use

BestQuest® has developed a revolutionary means of delivering supplemental math curriculum to middle school and high school students. This instructional advancement is *Algebra'scool*, a full year of standards-based algebra 1 resources delivered in a dynamic DVD format.

*Algebra'scool* uses an entertaining animation-based framework to capture students' attention and teach basic algebraic concepts rooted in real-world contexts. BestQuest developed the program through collaboration with technology and education/entertainment companies such as ComChoice, a leading digital media production house, and RubberBug, a leading computer graphics developer. *Algebra'scool* was designed to engage students in a way that engages their senses and arouses their interest, thereby promoting lifelong learning. The program uses original animation that students will find entertaining, but the content is comprehensive and rigorous, built on solid instructional methodology to ensure educators that their students are being adequately prepared for success according to any measure of academic achievement. Using characters that students can relate to, the program presents and reinforces concepts of algebra with accessible, relevant, reality-based instruction.

The DVD-based delivery of the *Algebra'scool* curriculum provides state-of-the-art instructional facility. 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.

The program is easy to use, requiring only a television connected to a DVD player. The program is comprehensive, consisting of 20 DVDs, containing a total of 99 lessons, and including an Instructor's Manual and Student Worksheet blackline masters, which are integrated into the instructional package and complement the instruction found on the DVDs. 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* to answer an unmet need in the math education market. Because middle school and high school students are held accountable for their academic performance since the advent of standardized testing under No Child Left Behind (NCLB), the company envisioned a program that would appeal to all students, including those not traditionally reached in an algebra classroom. BestQuest realized that middle and high school students are the driving force behind the recent explosion of animated programming in popular culture. Movies such as Adam Sandler's 8 Crazy Nights and television shows such as The Simpsons, South Park, and MTV's Daria appeal largely to teen audiences and have been successful in part because they address sophisticated, real-world issues through a medium traditionally viewed as child-centered. The company believed that the appeal of

animation in the youth-oriented entertainment industry could be replicated in the education market, and BestQuest set out to build a delivery tool that would incorporate the best instructional methodology even as it motivated 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*. It provides details of the scientific basis for the format and content of BestQuest's program to satisfy NCLB-based inquiries into the nature and validity of curriculum used in the K–12 market.

**Student Populations, Learning Styles, and Learning Modalities**

Because algebra is a part of the sequence taken by more than 50 percent of high school students to satisfy graduation requirements (Davenport et al., 1998), it is critical that all students are given every opportunity to succeed in the course. Minority students and females, however, have historically been less inclined to take algebra and to succeed. This is explained, in part, by the fact that they have not been afforded opportunities to build self-confidence in a learning environment that reflects their own interests. Marsh and Yeung (1998) find that students' academic self-concept has a direct causal relationship with their willingness to take a class and their subsequent performance in that class. This finding is paralleled by a study by Gohm et al. (1998), which shows that even students who are spatially "gifted" may do poorly in math class because they do not believe themselves to have the necessary capacity to succeed.

Research shows that such 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. For example, Mevarech and Kramarski (1997) find that with a multidimensional approach utilizing metacognitive questioning, peer interaction, and feedbackenrichment processes, students of any ability can succeed in math coursework. Brenner et al. (1997) claim 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. These findings are in line with the reform suggestions of the National Council of Teachers of Mathematics (NCTM). 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) show that even low-performing students do better with a problem-solving focus, as they stay on task and work toward an end they can understand and self-evaluate. One possible reason is that such students interact and participate in class because they are motivated, and consequently they have their weaknesses and strengths identified earlier so that interventions may occur. Another is that 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. In either case, 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; Olaf et al., 2001; Burkham et al., 1997). The need to inspire students so they enjoy learning math is a chief factor that led BestQuest to the animation format for presenting algebra concepts.

BestQuest's *Algebra'scool* utilizes a high-interest format to engage students in ways in which they have not been engaged before. Not only does the program utilize multiple representations and problem solving, it does so within the contexts of students' everyday lives through the interactions of the characters. Each character is modeled on a specific set

of common teenage traits so students can relate to him or her. These traits and the problems the characters face in the animations were defined and reviewed by practicing youth psychologists, in association with BestQuest's development team, to ensure that they reflect the everyday lives and personalities of today's students. Student diversity was a key concern in developing the characters so that socio-demographic diversity is reflected.

Through the combined effects of concept delivery and engaging storylines, *Algebra'scool* motivates students to learn math as they follow the characters through a series of adventures and misadventures. It encourages students to utilize creative thinking—a concept critical to the students' appreciation of math, because it incorporates both motivation and comprehension (Jalongo, 2003). Even students who have been accustomed to turning their thinking off when they walk into math class will be challenged by *Algebra'scool* presentation of topics.

**Technology and Math Education**

Iris Carl, past 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 have been among the earliest in the education community to embrace technology as both a delivery system and a subject for study. This is due to research, for example, that has shown computers supporting different learning styles by engaging more of a student's skills than traditional methods (Wang et al., 2001). 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 that they can readily understand and relate to due to the role that technology plays in their everyday lives. 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).

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 an 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. 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 of anxious teenagers walking into class. 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-stops built in so that mistakes or miscues do not ruin long blocks of classroom time. 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 on a home PC). 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 has potential to change the communication landscape, as digital information-sharing may ultimately prove as revolutionary as publishing was in relation to sharing of the hand-copied written word. 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**

The research on brain development and its optimal impact on math education deals largely with younger audiences. On the whole, the research shows that a window exists in which teachers may actually impact positively on the way students' brains develop by employing creative and participatory teaching methods. Sousa (1998) 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 in order 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 passed, 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. Through using music and multiple representations, the teachers is able to replicate the learning environment that students underwent in earlier brain development with the goal of fostering better learning even after the students' brains have, in a physiological sense, stopped "growing." 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, both creative and critical thinking, should be stressed.

Toward this end, 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* encourages 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 is 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, the initial research done was to determine whether creative and entertaining venues could be made with evident educational utility. Conti et al. (1995) argue that creative and engaging activities used in the classroom do, in fact, promote motivation for learning and spark creative thinking. But they also find that creative activities and resources are more 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 tool, provided it is used ultimately to support the delivery of a 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) find that no learning difference takes place among groups of students who use a print delivery system alone and those who use print with animation. However, they argue that using animation alone (or primarily) causes significant differences in students' learning. Similarly, Blankenship and Dansereau (2000) find that animation is more effective than either print alone or a print-animation mix in influencing students' recall in technical classes. Hall (1996) claims that animations used in biology classes were beneficial in their ability to reinforce student learning. All of these studies suggest that animation, if used as the primary tool for delivering content, can be useful and beneficial for students by promoting recall of algebraic concepts.

Olaf et al. (2001) have suggested a reason why animation is beneficial to student learning. Students who are motivated are more likely to learn. 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 as an idea whose time had come.

**Multimedia Curriculum and Resource 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 additional data that the student has to sort and prioritize and enables the student to develop real-world skills and increased mental capacity for information processing.

Mevarech and Kramarski (1997) also suggest 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, thereby constantly processing information from numerous sources. To teach with traditional read-and-drill methods is to put the students in a false environment. They 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 means of providing multi-sensory inputs is to include activities involving manipulatives. Ross and Kurtz (1993) claim that there are four rules for doing this effectively.

- There must be a choice of manipulatives.
- There must be adequate lesson preparation.
- There must be student participation.
- 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 only 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 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 has been shown to be 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 Lorach (1983) point 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 provides 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.

*Algebra'scool* is a visual program. 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 blackline masters 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 learners and participatory learners. *Algebra'scool* integrates these traditional and multi-sensory resources in a cost effective, engaging program for teaching algebra. 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 because they know their students are being adequately prepared for math success. BestQuest provides resources to the teacher so the 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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