DESTINATION Success™

# Math

*White Paper and Research*

DESTINATION Math®

# Destination Math: White Paper and Research

## Contents

# Destination Math: A White Paper

*"Mathematics instructional programs should use technology to help all students understand mathematics and should prepare them to use mathematics in an increasingly technological world."*

## Principles and Standards for School Mathematics; National Council of Teachers of Mathematics

Given the poor performance of U.S. students in mathematics, as measured by the Third International Mathematics and Science Study (TIMSS) and the National Assessment of Educational Progress (NAEP) reports, the need is urgent to improve the teaching and learning of mathematics in American schools. For example, "[t]he traditional approach to solving problems in U.S. classrooms is to teach a procedure and then assign students problems on which they are to practice the procedure. Problems are viewed as applications of already learned procedures." If teachers continue to teach mathematics in that way, the ability of students to meet the new standards in mathematics that have been established in every state of the union will be impossible. Now, all students at each grade level from K–12 are expected to demonstrate a basic understanding of a set of very specific objectives. Further, to graduate from high school today, students in most states are required to satisfactorily complete a course in algebra—currently a very tenuous goal.

The Destination Math® program is an exciting alternative to the traditional way of learning mathematics. It is a comprehensive computer curriculum that is uniquely designed to take full advantage of technology. The assumption behind the development of Destination Math is the belief that technology gives teachers and students new and exciting ways to explore the study of mathematics. This assumption rests on the development of three unique kinds of dynamic environments:

- *Active environments* in which student actions elicit computer responses that promote interpretation and reflection and give students greater opportunities to control their own learning
- *Sophisticated learning environments* that provide powerful aides to problem solving and that support learners by providing intelligent feedback, controlling physical processes, and displaying linked representations
- *Communication environments* in which all participants are connected via technology and are engaged in conversations not only about mathematics, but also about the larger world of home and work

Current research has demonstrated that using computers in education has a positive effect on learning, not only for students who have special needs, but also for students who are successful learners. Within Destination Math, students at various levels of understanding can assume greater responsibility for their own learning and navigate through a course at their own speed. The content to be mastered is presented in a logical sequence, is fully narrated, and is reinforced by motivating animations, graphic representations, and multiple interactivities that keep students focused on the subject matter.

Like most textbooks, the content within Destination Math is comprehensive and is designed to satisfy standards set by professional math organizations and state departments of education. That is, every lesson is designed around a set of learning objectives that correlates to virtually all national and state standards. Thus, teachers using the program can easily match the content of each Destination Math course to the scope and sequence that they follow in their math books and curriculum guides.

But Destination Math is far more than a textbook on the computer. Because of the nature of the medium, content comes alive in Destination Math. Audio and graphic animations are synchronized so that students are totally immersed in a full multimedia environment. Students can manipulate mathematical objects, such as geometric shapes and graphs, and investigate what properties change and what properties stay the same. They can see a visualization of the Pythagorean theorem that vividly demonstrates why, in a right triangle, $a^2 + b^2 = c^2$.

The curriculum within Destination Math is divided into six courses whose tutorial lessons and workouts address specific learning objectives. Thousands of test items available within Riverdeep's Learning Management and Assessment systems are individually correlated to these same learning objectives so that student performance on tests quickly reveals which objectives have been mastered and which have not. In the latter case, the computer or the teacher can assign remedial lessons to students. Conversely, students who demonstrate satisfactory understanding can move on to more advanced lessons in the course. Thus, Destination Math provides a complete world in which instruction and testing to standards can accommodate the individual needs of students in any grade and at any level of understanding.

## Content of Destination Math

Mathematics is all about solving problems. But learning mathematics requires that students not only acquire the skills necessary to solve problems, but more importantly recognize what skills they must use to solve problems. Each of the Destination Math courses explains in great detail not only the "how" of mathematics (its skills), but the "why" (its concepts). Some of the most robust features of Destination Math are as follows:

- The substance of each tutorial lesson centers around one or more "powerful ideas," such as what it means to count a set of objects (cardinality), and what place value means (powers of 10).
- The content is presented as a series of connected ideas that starts with the prerequisite knowledge that students should have and moves on in a systematic and coherent way to introduce new concepts and skills.
- Synchronized narratives and graphical animations reinforce the presentation of the content so that students grapple with mathematics within a highly visual, dynamic, and aural environment.
- The content has a coherent structure with new terminology introduced as needed, defined using clear language, and reinforced in a consistent manner.
- The content is spiraled: ideas introduced in one lesson often reappear in a subsequent, seemingly unrelated topic.
- The context of many lessons emphasizes the importance of mathematics, demonstrates its applications, and reflects highlights of its history.

According to the NCTM, the use of technology in mathematics instruction has made the study of some mathematical topics possible and the study of other topics obsolete. This is reflected in the design and content within each of the two Mastering Algebra courses. For example, where once the study of complex graphs and functions was postponed until upper secondary school, these objects can be introduced much earlier into the curriculum. The technology permits students to see and manipulate multiple representations of algebraic and geometric objects. In the two algebra courses, students can drag graphs on the screen and see their equations change, or they can change the equations and see the effects on the graphs. The interactive nature inherent in the use of computers means that students can become more personally engaged with the content.

Contrary to concerns that an increased use of computers would contribute to student isolation, research shows that using computers increases social interactions between teachers and students and between students and students about the subject to be learned. Such interactions, focused around the use of computers, hold the promise of increasing students' success rate in algebra. This is particularly significant because most school districts in the U.S. now mandate that all students take and pass algebra to graduate from high school.

The Destination Math algebra courses are designed to provoke students to think about mathematics, its history and applications, and to see how people from various walks of life use mathematics to solve realistic problems.

Within the two Destination Math algebra courses, mathematics is presented in the form of animated short stories accompanied by a continuous conversation between two curious adults who observe the world, asking each other questions, and searching for explanations and meaning. The content of their conversations focuses on mathematics and its applications and is reinforced and supported by colorful animations, graphics, sound, and onscreen text. These armchair travelers journey about the world, past and present, and view it through mathematical lenses. As they wander, their observations guide students through a logical development of mathematical ideas.

The beginning of each story sets the stage for a context that poses a question or presents a problem to be solved. The narrators investigate the aspects of the context and build connections between what students know and what they are to learn. Students participate in the narrators' observations by responding to questions the voices pose and seeing and hearing their responses evaluated. Feedback after each interaction explains the reasoning behind the correct answer to a question.

Like many good stories, each tutorial has an ending that includes a wrap-up of what the narrators (and the students) have learned and a summary of the important mathematical ideas presented within the tutorial. There is no ambiguity for the student. They can clearly see what it was they were to learn and if they didn't "get it," they can go back and repeat any sequence within the tutorial.

## Using the Product

Destination Math can be used by teachers and students in a variety of ways depending on the grade level, the ability of the students at that grade level, the availability of hardware, and the comfort level of the teachers and administrative support they receive.

## Presentation Mode

Within a classroom, teachers can use Destination Math in a presentation mode. Teachers can project the Destination Math lessons on a large screen monitor to the whole class. Teachers can choose a particular lesson and use it as the focus of a class or part of a class. Or they can use a lesson to introduce a new topic or to reinforce instruction already provided. The navigational features designed within a course let teachers pause the program at any point and ask students leading questions. They can have students participate in the interactivities as a group and use the feedback provided within the software to explain the solution to a problem in more than one way. Based on how students respond, teachers can repeat a segment of a tutorial lesson, present an explanation in the "Show Me" section of a workout, reveal the solution to a practice problem, or branch forward or backward to a related topic in a different unit, module, or course. This flexibility can certainly be used to more deeply enhance the current state of instruction in most mathematics classrooms.

## Individual Student Learning

The content within each course is designed to motivate the student learner. Just as teachers can use the navigation buttons to move through a course, students can similarly immerse themselves in each environment and move forward and backward at will. As they move through a tutorial, their responses to the built-in interactivities are evaluated and they receive feedback that acknowledges correct answers and corrects incorrect or skipped responses. The practice problems within a tutorial are short questions that apply the objectives to be learned and provide simple explanations.

Workout problems present more involved types of problems, and lengthy and detailed explanations include productive strategies that can be used to solve and check a given problem. All of what a student does within a Destination Math course is reported through the Learning Management System, so whether teachers are present or not, they have direct access to how long a student spent working online, how much of a lesson a student completed, how well a student did on the problems confronted, and which objectives were mastered. Thus, teachers have a complete synopsis of what students accomplished during their time using the course.

## Collaborative Student Learning

Students can go through a tutorial together, helping each other to understand the content as it unfolds. Each Destination Math course engages the students' attention and makes learning math fun and interesting. By providing realistic contexts, the courses also serve to answer the questions, "Why do I have to learn this?" and "Who ever uses this stuff?"

## Evaluation and Assessment

The Learning Management and Assessment systems give teachers a powerful way to plan for instruction and to correlate student assignments to district objectives. Teachers can monitor how well their students are doing by reviewing reports created by the system, which can be printed or viewed online. Through the Learning Management System, teachers can assess student performance by generating tests correlated to a set of specific objectives at different levels of difficulty and assigning them to students. Depending on student performance, teachers can reassign courses that teach the objectives that students did not master.

## Comprehensive Curriculum

In December 2000, the U.S. Department of Education released its e-Learning Report that recommended five National Educational Goals:

1. All students and teachers will have access to information technology in their classrooms, schools, communities, and homes.
2. All teachers will use technology effectively to help students achieve high academic standards.
3. All students will have technology and information literacy skills.
4. Research and evaluation will improve the next generation of technology applications for teaching and learning.
5. Digital content and networked applications will transform teaching and learning.

One of the most important ways teachers can reach some of these goals is to have quality software that enhances their teaching and promotes greater student achievement. In mathematics, the need for student achievement is particularly acute. Destination Math provides a unique way to change the way teachers teach and students learn mathematics. Destination Math is a quality, comprehensive curriculum intended for classroom use that provides benefits textbooks alone cannot provide, and it is easy to implement and use.

## Conclusion

Phillip Davis and Reuben Hersh, writing in *Descartes' Dream: The World According to Mathematics*, observe that mathematics has become the new gatekeeper in our society; the critical filter for most of today's careers and professions. Yet, mathematics instruction in the U.S. is still not focused around NCTM's goal of "mathematics for all."

In an effort to respond to the need for all our students to become mathematically literate, more and more school districts are requiring that all students study and pass algebra before graduating from high school. But meeting this goal using standard practices will be difficult, if not impossible. There is still a large difference between what TIMSS refers to as the "intended curriculum"—that is, what teachers are expected to teach, the "implemented curriculum"—what teachers actually teach, and the "attained curriculum"—what students actually learn. According to TIMSS, the mathematics curriculum, including the algebra curriculum, must be more focused, have greater depth and "… provide rigorous, powerful, and meaningful content..."

The computer and, particularly, Destination Math are alternatives to the traditional way that the curriculum is presented and received. Destination Math moves teaching and learning mathematics into the 21ST Century by taking advantage of the technology to create a unique environment to help school districts realize their goals.

## Professional Development at Riverdeep Interactive Learning

Professional Development at Riverdeep Interactive Learning is not so much the "training of people" as it is "development with people." At Riverdeep, we recognize that excellence in teaching and learning begins with the classroom experiences of caring and knowledgeable professionals committed to the strengthening of student achievement. As we help real teachers working in a great variety of circumstances, we honor our responsibilities to what research has established to be the hallmarks of excellence in adult learning.

The literature on professional development and adult learning is vast but from it, Riverdeep has distilled four guiding principles:

- First, the professional development must be rooted in—and innovatively responsive to—the real experiences and needs of educators. Gone are the days of the "off-the-shelf" training sessions that disregard audience. Riverdeep training is built around what teachers need to learn. What participants come to learn has therefore a greater relevance, which then ensures teacher and administrator buy-in and commitment.
- Second, Riverdeep training promotes collaboration among those being trained. Individual teachers working alone can accomplish a great deal, but these gains can be increased exponentially when teachers work together on projects of mutual concern. This is what we intend by "building capacity," namely, harnessing the individual energies into something greater than the sum of its parts. This begins with the initial trainings and continues throughout, for it is Riverdeep's insistence on the power of a high-functioning community of learners that we believe best promotes a more sustained and powerful implementation.
- Third, our trainings are not garden-variety, "sit-and-get" sessions with minimal acknowledgment of the real world of teaching. All Riverdeep professional development activities are built around hands-on learning. After teachers acquire a baseline understanding of the essential features of the software, subsequent training is focused on teachers' developing real solutions to actual classroom situations. In this way, the transfer of the professional development into actual learning environments is built into the program.
- Finally, research has shown that learning is best accomplished in an interactive environment, a setting in which the learner has an opportunity to influence the course of the learning and make it more meaningful. Riverdeep professional development, with its emphasis on the real-world contexts, ensures that teachers have ample opportunities to create lesson plans and tests that can be implemented "Monday, not some day." With its suite of feasible solutions, generative assessment instruments, and empowering content, Riverdeep professional development takes the best of what is known, shapes it to local conditions, combines it with the best in educational software, and follows through with compelling and informative evaluations.

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DESTINATION Math®

# Supporting Student Numeracy Project

June 2003

## Introduction

The objective here is to achieve a vision whereby the classroom, school, and district have the ability to provide engaging and varied mathematics instruction, with accommodation for those who need it. This is an enormous challenge. Students, as we all know, need the best mathematical education to fulfill personal ambition and career-goals. At the same time, new knowledge, tools, and ways of performing and communicating mathematics continue to change and evolve.

Students of all grade levels have trouble understanding math concepts, carrying out required mathematical procedures, and correctly solving mathematical problems. The students exhibit different talents, abilities, achievement needs, and interests in mathematics, which in turn requires varying resources and opportunities to attain a substantial understanding of the importance of mathematics. Computer-aided instruction has been identified as one effective tool to assist students with a wide range of math intervention (remediation, enhancement, and enrichment). Students who have been given the opportunity to use appropriate technology often demonstrate persistence, enjoy the learning, and make noticeable gains in performance.

## District Numeracy Project Summary

### Student Numeracy Needs

Students need to develop a rationale as to why math is necessary. Building a context where students solve real-world problems using mathematics is a great motivation for the need to develop numeracy skills. At the same time, there is a need to support all students, at all levels, with resources to help personalize their learning. Students have different learning styles and rates, so access to materials that help support a more flexible learning environment are of value. In addition, access to resources should be available anytime and anywhere so learning can continue outside the classroom yet still be managed by educators.

## Project Implementation and Accountability

The Greater Victoria School District partnered with Riverdeep (Destination Math) and IBM Canada to help reduce the project's implementation costs and to share technical and educational knowledge and expertise. The District installed 100 Destination Math licenses (in each of seven course modules) on a Web server shared by participating schools. Implementation support was provided: educator releases (to attend introductory Destination Math workshops), user group meetings, and lesson plan development sessions. Participating schools cost-shared on the hardware to be used in the project.

An accountability process was developed to promote effective use of resources. Schools applied for participation in the project and were responsible for fulfilling the commitments documented within their application. Each of the schools targeted a minimum of 20 students as their test group within their school's implementation. Students' progress and usage was monitored through the software's Learning Management System (LMS).

At the same time, the TOMA-2 assessment test (an external tool with sub-tests that measure students' attitude, vocabulary, computation, story problems, and general information in mathematics) was used as part of the accountability process to help promote effective use of these resources.

## School Implementation Plan/Application to Participate

Thirty-four schools submitted (one page) Implementation Plans, which addressed the following areas:

- Identify the student target group(s) and the number of students (minimum of 20 students) that will use the system. Also identify the type of needs you are planning to address for each group (Addendum: Student Usage Models).
- Identify staff that will participate (with implementation of the system) and their roles.
- How will students be scheduled to share the system?
- Describe the operation of the learning environment (that is, classroom, mini lab pod, resource room, etc.) in which these computer systems will reside.
- A standardized pre/post assessment instrument (TOMA-2: Test of Mathematical Abilities, Second Edition) has been identified for use in this project.

# Project Highlights

*"Provide Educators with resources to support their work [that are] mathematically rich, offering student's opportunities to learn math concepts and procedures with understanding."*

The Numeracy Project (Destination Math) implementation began mid-October with students monitored until mid-May. Over 150 educators attended introductory workshops. Approximately 100 educators and 2400 students were "active" users of Destination Math for the duration of the project. At the end of May 2003, educator, student, and parent surveys were provided to each of the 34 participating schools. The users were asked to share their achievements of the past six months (highlights, challenges, and successes) and the data collected, both qualitative and quantitative, would be compiled and reported out.

Sixty-five percent (65 percent) of the participating educators completed and returned surveys. Completion of the student and parent forms was optional: thirty-five percent (35 percent) of schools returned student forms; and eighteen percent (18 percent) of parent forms were received. Forty-three percent (43 percent) of the students used the program to supplement their math curriculum while thirty-five percent (35 percent) worked through various units as part of their regular math class. The remaining twenty-three percent (23 percent) used the program as self-paced learners (due to illness, absence, or for content review).

For the purpose of the implementation of this project, these components were identified as those that enhanced the potential for student gains in mathematics and were successfully demonstrated in a number of schools.

Appropriate Implementation – Procedures being taught online matched those being taught in the classroom. Some computation procedures used in the software were unlike those in the class instruction and this at times produced conflict in math instruction. When the lessons were blended with classroom instruction, students became aware of varying methods used to solve a problem. This provided an opportunity to discuss different approaches and why more than one method is often available to compute an answer.

- Students were given activities/tests prior to new units or materials in the classroom as a way to introduce (or re-introduce) a new concept.
- Riverdeep's Destination Math was used as a center activity.
- Destination Math activities provided additional instructional strategies for classroom teachers:
  - A good intervention resource that supported math curricular objectives.
  - Encouraged "mathematical literacy."
- Activities were used to complement the class – demonstrating the same mathematical concept but in a different manner.
- Promoted conceptualization of new teaching strategies (incorporating the use of computers in the classroom).

Personalized Learning– Destination Math courses could be modified, which provided flexibility in creating assignments, number of problems to complete, and at varying instructional levels.

- Students had specific tasks to perform and activities to work through that were consistent with classroom work:
  - Provided for more individual contact time (students to teacher)
  - Allowed students to finish "incompletes" at a later time
  - Allowed students to complete missed assignments at their convenience
  - Allowed students to work at various levels of the same concept
  - Allowed for more individualized instruction when necessary
- Students were empowered with the understanding that mathematical knowledge comes from a variety of resources.


Students Received Feedback and Built-in Motivation – For the self-paced or independent learner, the application provided some clues to correct answers when an error was made. It limited the number of attempts at any one question, and provided a "Show Me" option, which re-introduced the concept to ensure there was a level of understanding.

Informative Performance Feedback – Within the Learning Management System (LMS), teachers obtained reports on class and student progress, which clearly articulated areas of strength and areas of weakness. Some reporting from within the LMS was used in student report cards, or reviewed in student-led conferences with the student, parent, and teacher discussing the results.

- Curriculum, technology, and teaching strategies were aligned to match the students' learning needs.
  - Teachers were able to assess their students' needs and create appropriate assignments.
  - Individual or classroom-level assessment of specific mathematical concepts was available.

Virtual Manipulative – Real-life simulations provided built-in instructional aids for teachers.

- Units covered were level-appropriate with good graphics for students.
- The lessons were viewed as good conceptual and complementary learning tools.
- The application provided a visual representation that helped students connect between a mathematical expression and the situation where it might be used. When applicable, students were able to manipulate illustrations turning the problem into a mathematical experience. (See figure below.)


## TOMA-2 Results

The TOMA-2 measures math performance of major skills (Vocabulary, Computation, Story Problems, and General Information). For ease of comparison, all standardized test scores are given in percentiles. A percentile rank (PR) refers to the number of students of similar age (on a scale of 0-100) who would be expected to score equal to or lower than a tested individual on a particular measure. Thus, for example, a student who achieves a PR of 78 in TOMA-2 could be said to perform at an above average level (that is, better than 78/100 similar aged students who perform the task, but not as well as the remaining 22 in the normative sample). A percentile rank between the 25$^{th}$ and the 75$^{th}$ percentiles is considered to be within "normal" limits.

The following graphs represent average gains across the numeracy project student sampling. Clearly, some individual students made significant gains, while others less so, and a number of variables must be taken into account. However, an attempt has been made, given limitations of time and personnel during this complex pilot implementation year, to provide an objective indicator of the program's potential, in addition to the more subjective data. Analysis of all data, including test scores, direct observations, and feedback from those participating in the program during the past six month, clearly supports the value of this web-based, computer-directed learning resource.

The first three charts illustrate examples of schools that integrated Destination Math into their regular math program. Students' time-on-task was from 20 to 45+ hours.

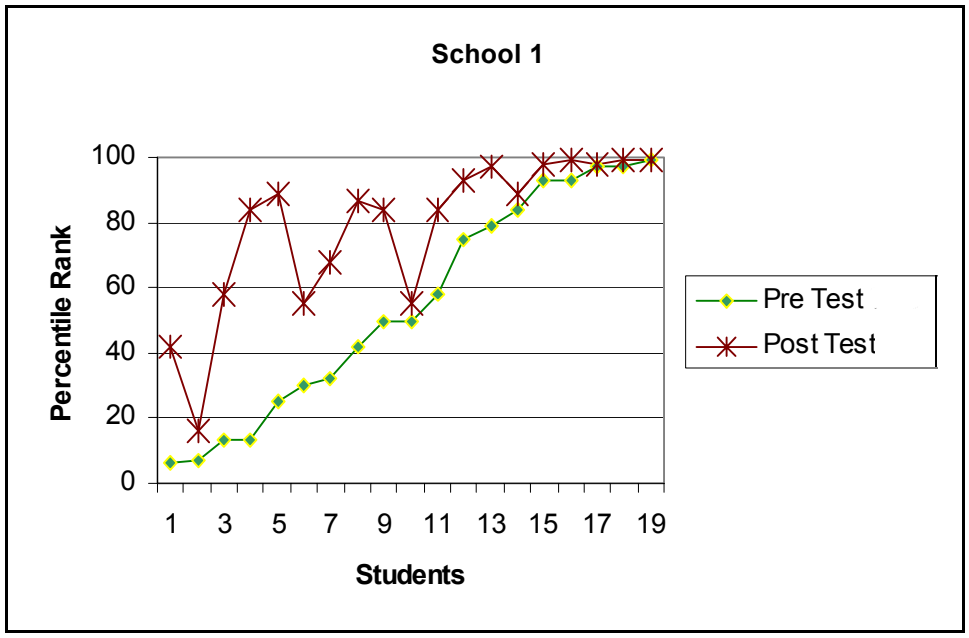



*Chart 1: Student Usage Model - B*

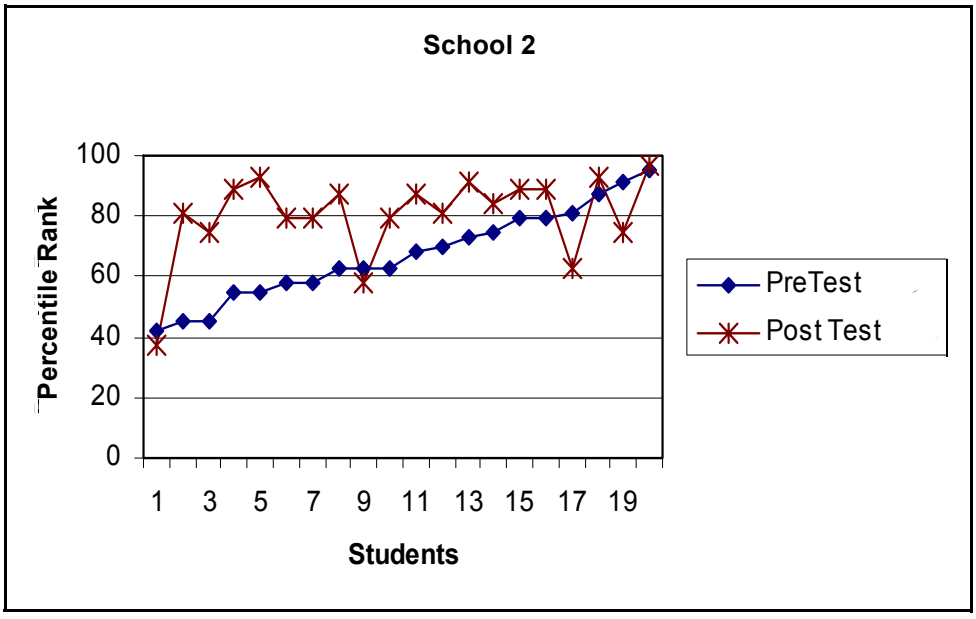



*Chart 2: Student Usage Model – A & B*

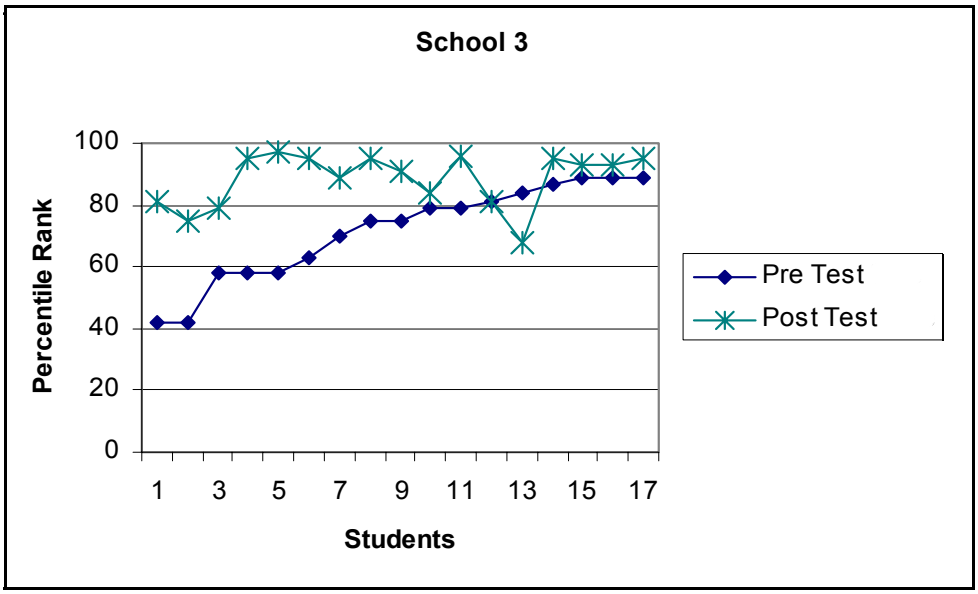



***Chart 3: Student Usage Model A & B***

Schools using Destination Math on a sporadic basis (either for short-term remediation or fill in) are illustrated in the following two charts. These students used the program for less than 10 hours.

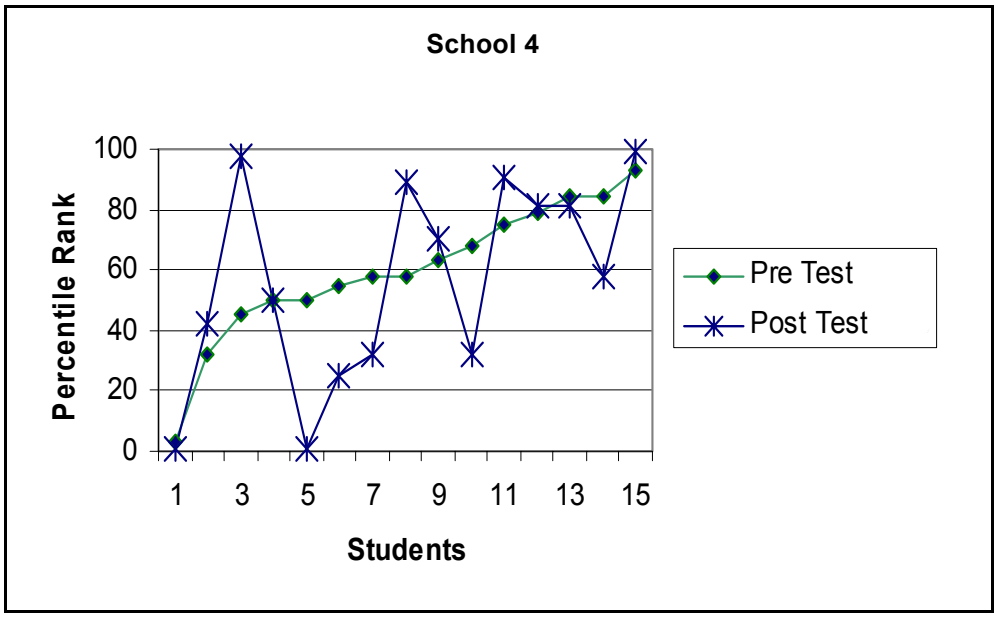



***Chart 4: Student Usage Model - A***

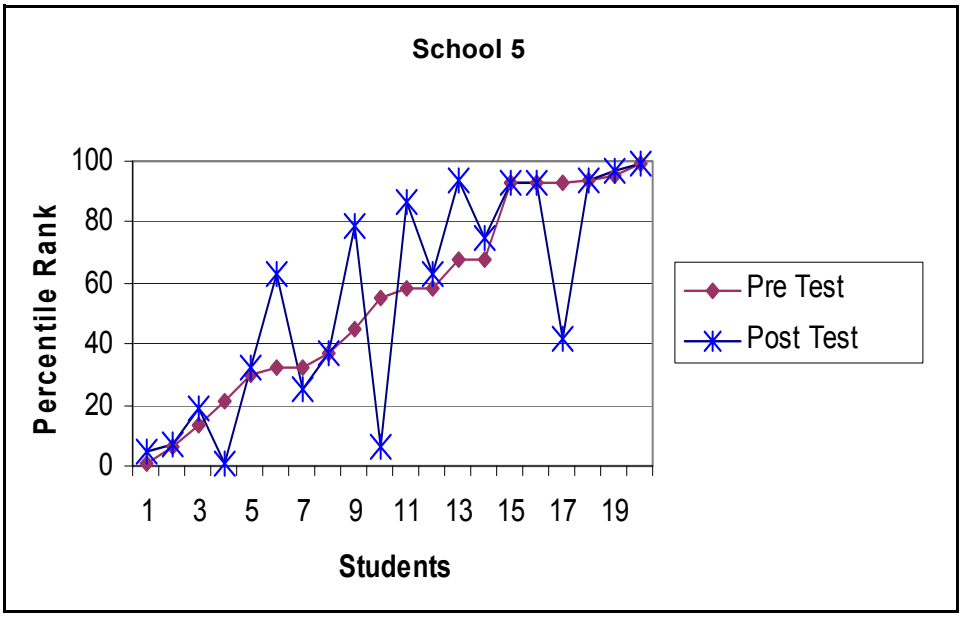



*Chart 5: Student Usage Model – A*

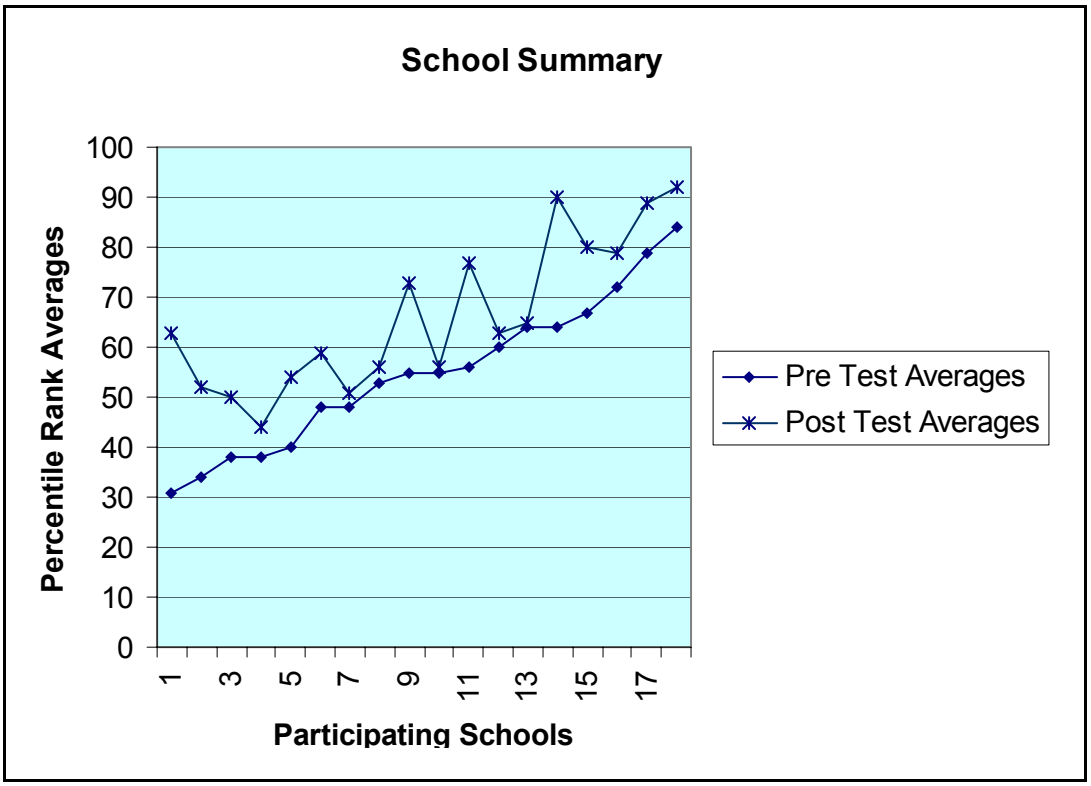



*Chart 6: Percentile rank average gains of all schools completing pre and post TOMA-2 test results. The average pre-test (November 2002) percentile score was 53 percent and the average post-test (May 2003) score was 64 percent.*

# Addendum: Student Usage Models

The following models were suggested that use the software to support student numeracy needs.

**Model A:** Supplemental Usage Model

- Supports student knowledge gaps.
- Requires diagnostic testing to determine specific needs.
- Learning is structured and focused.
- Requires high level of teacher intervention.
- Usage time varies depending upon type of activity assigned (typically at total of 5 to 10 hours).
- This model may not show significant numeracy gains through TOMA-2.
- This approach may be best for special needs students in a resource room.

**Model B:** Integrated Usage Model

- Supports regular class activities.
- Used to introduce and/or reinforce concepts/skills.
- Learning path defined by curricular activities assign by the educator.
- Educator monitors progress and ascertains need of intervention.
- Used weekly (30-60 minutes).
- Approach of use for all students.

**Model C:** Facilitative Usage Model

- Facilitates independent learning.
- Predefined lessons replace some regular class instruction.
- A different instruction delivery for different learning styles and rates.
- Educator monitors but student more responsible for requesting intervention.
- Learning model can effectively use some home access.
- Used continuously (60-120 mins/wk).
- Best for more self directed learners.

**Model D:** E-learning Usage Model

- Facilitates independent learning.
- Apart from regular class activities/instruction.
- Can be supplemental or an enrichment of curriculum.
- Activities/lesson to meet individual needs.
- Monitored and support by an e-mentor.
- Accessed from home or other areas.
- Best for students with extraordinary needs (that is extra support, timetabling/scheduling, traveling, etc.).

## Selected Comments

Educator Comments

- Provided clear, concise instruction / lessons that could coincide with class instruction.
- Worked well as weekly review.
- The software demonstrates visually for those students who need it.
- Good as a practice tool for students.
- Use of simulations gives the students greater concept of math problems.
- Testing components highlight areas of greatest need.
- Web-based materials facilitate parent/student/teacher collaboration.
- District developed correlations of BC Mathematics outcomes with Riverdeep's Destination Math content.

Student Comments

- I learned a lot about other subjects while doing Math.
- Yes, I went from a C- to a B+ in Math.
- I found it interesting how they made the questions into real-life situations.
- A computer alone shouldn't teach math because you can't ask it questions, but I liked working at my own pace.

Parent Comments

- Fun to use and enabled child to learn new math procedures in an easy to use format.
- Yes – it was a different way to learn math.
- Student was able to move ahead once concept learned.
- It was visually interesting, fun to use, and easily accessible. Student felt successful upon completing exercises.
- Great reinforcement.
- Provided variety, more interest; minimum supervision required.
- The units were clear to understand and enforced the learning through interactivity when answers were not correct.
- Yes – repetitiveness is beneficial.
- Accelerated student learning rate because it had a visual aspect.
- Provided the parent with access to what the student was working on.

# Summary of School Information (from Surveys)

Surveys received:

| | | |
|---|---|---|
| Teachers | 123 | (25 schools) |
| Students | 157+ | (12 schools) |
| Parents | 20 | (6 schools) |

Student pilot group grades were as follows: (1623 reported student participants)

**Student Participation by Usage Model**

| Grade | Model | | | |
|---|---|---|---|---|
| | (A) Supplemental | (B) Integrated | (C) Facilitative | (D) E-Learning |
| K | 15 | 19 | | 35 |
| 1 | 15 | | 4 | 4 |
| 2 | 25 | 65 | | 21 |
| 3 | 28 | 75 | 2 | 43 |
| 4 | 58 | 55 | 8 | 13 |
| 5 | 5 | 102 | 20 | |
| 6 | 111 | 117 | 84 | 30 |
| 7 | 126 | | | |
| 8 | 174 | 75 | 23 | 7 |
| 9 | 77 | 57 | 6 | 60 |
| 10+ | 64 | | | |
| | 698 | 565 | 147 | 213 |

## Operation and Logistics

This table identifies the number of reported students, the grade levels, the average time-on-task over a week, where the access occurred, and what component(s) of Destination Math were used by the classroom teacher.

| Usage Model | # of Students | Grade | Time-on-Task[1] (average) | Access Locations | Components Used* |
|---|---|---|---|---|---|
| **A**<br>**Supplemental Usage**<br>*supports knowledge gaps<br>*structured focus on learning | 698 | 1-10 | 30 mins/wk | 27 Class<br>13 Lab<br>7 Library<br>17 Home | 29 Activity<br>13 Tests<br>8 Lesson Plans<br>15 Exploratory |
| **B**<br>**Integrated Usage**<br>*introduce new concepts/skills in class<br>*reinforce math concepts/skills | 565 | K-10 | 30 mins/wk | 21 Class<br>13 Lab<br>3 Library<br>10 Home | 22 Activity<br>10 Tests<br>8 Lesson Plans<br>5 Exploratory |
| **C**<br>**Facilitative Usage**<br>*independent learning<br>*custom developed lesson modules | 147 | 1-10 | 30 mins/wk | 14 Class<br>2 Lab<br>4 Library<br>3 Home | 16 Activity<br>9 Tests<br>4 Lesson Plans<br>11 Exploratory |
| **D**<br>**E-Learning Usage**<br>*supports supplemental learning<br>*enrichment of curriculum | 213 | K-9 | 30 mins/wk | 13 Class<br>3 Lab<br>4 Library<br>6 Home | 11 Activity<br>6 Tests<br>2 Lesson Plans<br>9 Exploratory |

* Components

- Activities: Software lessons / exercises that are selected and assigned to a student. These can be created using Riverdeep's scope and sequence or with the newly imported B.C. Mathematic outcomes
- Tests: Online tests that can be tracked and used to identify student strengths and weaknesses
- Lesson Plans: An educator tool that enables one to group activities, tests, learning outcomes and other information into a template that can then be shared with other educators.
- Exploratory: Educators and students are able to freely explore all content areas of the program (no tracking of student progress or accomplishments)

DESTINATION Math®

# RMC Research Corporation National Survey Results

September 2000

## Executive Summary

In May 2000, the Portland, Oregon firm RMC Research Corporation conducted a national survey of Riverdeep users. Respondents were asked a broad range of questions regarding their activities and experiences with Riverdeep products, including the resources found on the www.riverdeep.net Web site. Nearly three quarters of the respondents worked in secondary schools, with the remaining fourth working in various other types of school settings. Over half of the respondents reported having used Riverdeep products for over one year. The students served by the responding teachers represent a broad cross-section both in terms of socio-economic status and levels of academic achievement.

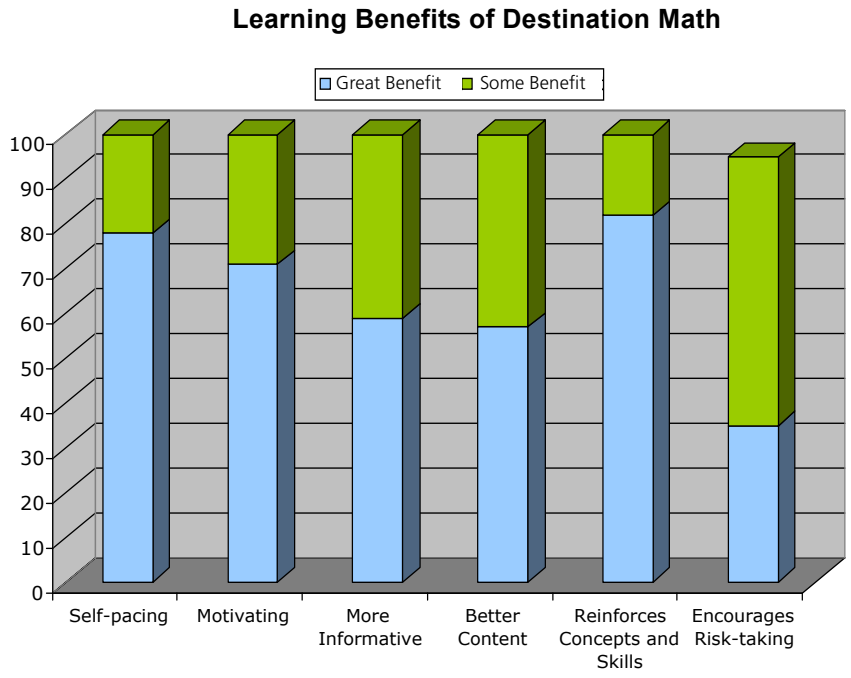
Drawing from a pool of over 800 users, the survey results provide insights into the experience of Riverdeep teachers and administrators from across the country. The positive results of the survey stand as clear testimony to the educational worth and power of Riverdeep products as they reach an ever-widening audience of teachers, students, parents, and others. Riverdeep products again and again demonstrated the flexible and adaptable qualities that allow students in varying settings to achieve all their capabilities. Teachers have been empowered to reshape instructional materials, to make subject matter come alive, and to engage learners in new and more educationally productive ways.

## Riverdeep.net

One of the central areas of concern was the value of the riverdeep.net portal to educators. As a focal point of Riverdeep efforts, the data (expressed below in percentages) provide a considerably gratifying picture. Educators are making frequent use of the many resources at the Riverdeep Web site, with many returning to it consistently for homework assignments and other learning resources.

# Destination Math

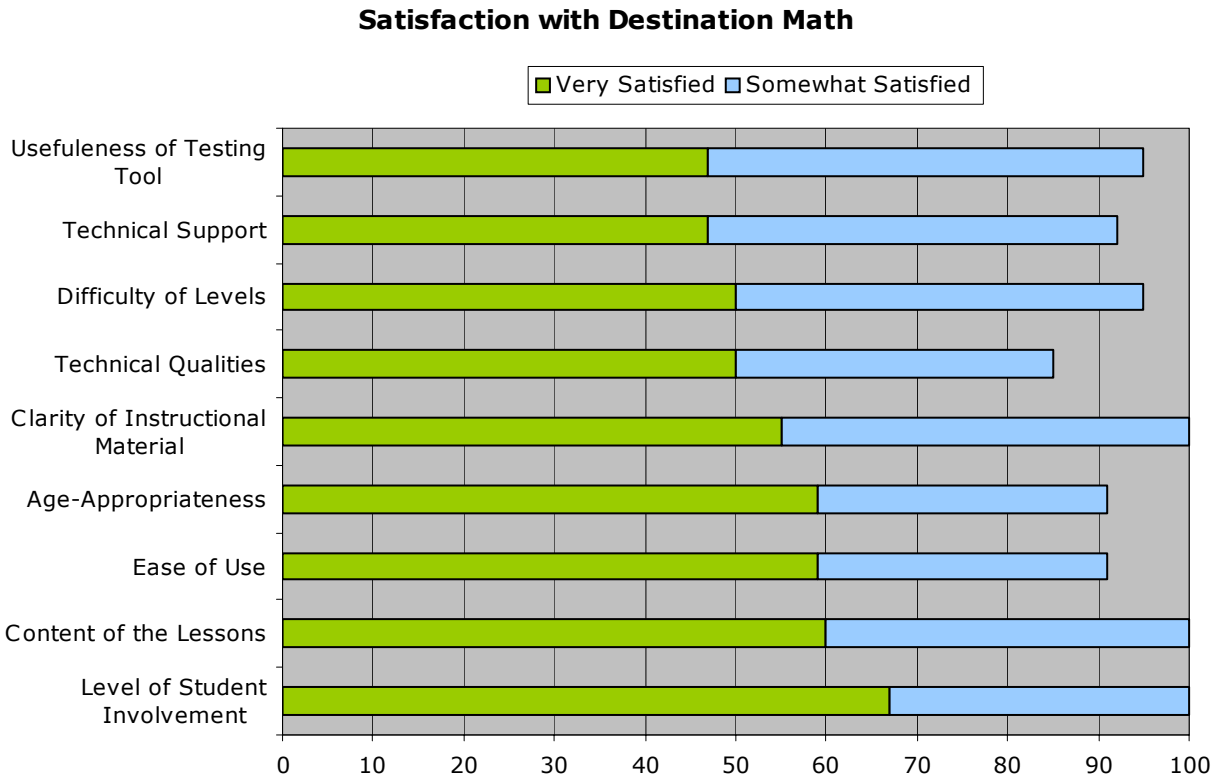
About a third of survey participants reported using Destination Math as the primary instructional tool at least once a week. Over 80 percent of respondents use the software to supplement instruction, with nearly 40 percent of these using Destination Math as a supplement on a routine basis. The benefits cited by the respondents varied in kind, though not in enthusiasm. The following chart shows benefits (expressed in percentages) and illustrates this finding:




Here is a sample of comments from the respondents:

- "Some students may not understand a concept no matter how many times you explain it, but after doing it on Destination Math, they can come to class with an understating of it."
- "Because of access to the curriculum from several areas within the school, students are using the material more. There is an intrinsic desire to use the technology to gain knowledge."
- "[I use it] to strengthen concepts covered in class and to review concepts that have not been discussed in a while."
- "Destination Math is a wonderful experience for the gifted young student. The courses provide additional opportunities to apply learned concepts to real-life applications."

The following chart illustrates the patterns (expressed in percentages) of satisfaction among respondents to various aspects of Destination Math.




More than 90 percent of respondents rated the Destination Math courses as good or excellent, with all respondents saying that they would recommend Destination Math under certain conditions.

# Conclusion

Across the country, Riverdeep teachers are sharing resources to create and implement the most thoughtful uses of educational technology. The teachers in this survey represent a growing community of educators committed to excellence for all students. The fact that these educators have turned to Riverdeep to address significant educational challenges in many different settings stands as testimony to the Riverdeep commitment. Innovative, standards-based, and technologically enhanced, Riverdeep materials have enjoyed local success wherever they are used. The benefits to students are as clear as the enthusiasm of the educators within this survey.

DESTINATION Math®

# Destination Math: Engaging Students' Critical-Thinking Skills

## Executive Summary

During the spring 2001 school semester, Pennsylvania State University educational technology researcher Dr. Sarah Fitzpatrick investigated the implementation of Destination Math in two Eighth grade classes in rural Tussey Mountain Junior–Senior High School in south-central Pennsylvania. A central research question was "Does using Destination Math help to increase students' higher-order thinking?" Destination Math was found to be an effective tool for increasing students' higher-order thinking in their math class.

## Cognitive Contexts for Mathematics Learning

Researchers have long been in agreement that the patterns of thinking in which subject matter is learned has a great deal of effect on both the amount of learning retained and the eventual "portability" of learning into new contexts. For learning to increase the amount and transferability of knowledge, students need to acquire deeper understandings of concepts. This deeper understanding is linked to what has come to be called "higher-order thinking," in which the student works with material of greater cognitive complexity. For educators, the challenge of creating and sustaining complex cognitive contexts is enormous. The focus for this research was the extent to which Destination Math can provide a cognitively complex context for learning mathematics in such a way that students use more higher order thinking.

## The Implementation

Tussey Mountain Junior-Senior High School is situated in Bedford County, Pennsylvania, which has 65 percent forested land and 25 percent farmland, and ranks 63rd in the state's 67 counties in per-capita income. During the fall 2000 school semester, Dr. McCahan, the Assistant Superintendent of Tussey Mountain School District, looked to technology to increase students' understanding of, and competence with, math. Dr. McCahan spearheaded the school district's purchase of 232 five-year Riverdeep subscriptions for Eighth grade students at Tussey Mountain Junior–Senior High School. Eighth grade is a benchmark year for students in Pennsylvania who take the Pennsylvania System of School Assessment (PSSA) mathematics exam in April of their Eighth grade year.

In January 2001, thirty-two Eighth grade students at Tussey Mountain Junior–Senior High School began using Destination Math with Mrs. Winfield, a veteran math teacher at Tussey Mountain, and the first teacher to use the Riverdeep resources with students in the school. Students accessed Destination Math twice weekly from their school's computer lab during their regularly scheduled forty-minute math period with Mrs. Winfield. Students used the district-adopted Saxon math scheme on the alternate days. Observational and interview data were used in tandem with student test and progress reports to develop an in-depth understanding of students' and their teacher's use of Destination Math.

## Engaging Students' Critical-Thinking Skills

Prior to implementing Destination Math with her Eighth grade students, Mrs. Winfield thought that Destination Math would "support the students' actual thinking and open-ended skills very well." When later asked how she felt about her students learning with Destination Math compared with the regular textbook-driven math class, Mrs. Winfield responded that Destination Math provided increased opportunities for her students to engage in higher-order thinking skills: "It [Destination Math] gives the students more freedom as to how they're going to approach something. They get to use more critical thinking skills. I have to get used to that, cause I guess, in mathematics we're always looking for the right and the wrong answer. A lot of times everything's black and white in mathematics, although we're trying to get away from that now."

## Classifying Students' Cognitive Activities with Destination Math

This research investigated students' levels of cognitive engagement while working on Destination Math tasks by first recording and then classifying students' thinking about, and knowledge of, math concepts. To extend the research base on student interaction with Destination Math, the focus of this research was on the process of student engagement with Destination Math, rather than the product or outcome of this interaction (represented by test scores). Bloom's Taxonomy of Educational Objectives was used to organize students' cognitive activities while using Destination Math into two broad categories: lower-order thinking skills (LOTS) and higher-order thinking skills (HOTS). Students' cognitive activities were further analyzed according to the level of cognitive engagement demonstrated—ranging from the simplest intellectual (cognitive) behavior (Level 1—recall or recognition of facts) to the most complex (Level 6—evaluation). Table 1 presents verb examples of students' cognitive activity at each level of the taxonomy.

***Table 1: Levels of Cognitive Activities Demonstrated by Eighth Grade Students Using Destination Math***

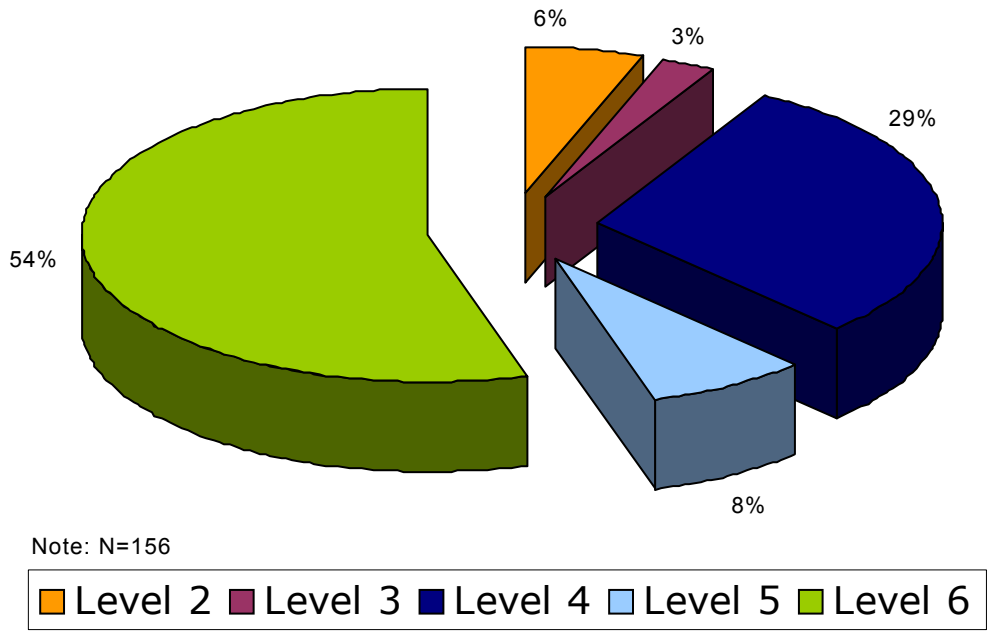
| Cognitive Activity | Level | Category | Cognitive Activities Demonstrated by Students |
|---|---|---|---|
| **Lower-Order Thinking (LOTS)** | 1 | Knowledge | Define, Enumerate, Identify, Label, List, Match, Name, Read, Reproduce, Restate |
| | 2 | Comprehension | Classify, Cite, Convert, Describe, Discuss, Explain, Paraphrase, Summarize |
| **Higher-Order Thinking (HOTS)** | 3 | Application | Apply, Choose, Demonstrate, Employ, Implement, Operate, Practice, Report, Teach, Transfer, Use, Write |
| | 4 | Analysis | Analyze, Break down, Calculate, Correlate, Diagram, Differentiate, Discriminate, Distinguish, Illustrate, Outline |
| | 5 | Synthesis | Arrange, Assemble, Compare, Contrast, Create, Design, Formulate, Integrate, Negotiate, Plan, Rearrange, Reconstruct, Reorganize, Substitute |
| | 6 | Evaluation | Appraise, Argue, Assess, Choose, Compare, Conclude, Critique, Defend, Estimate, Judge, Justify, Evaluate |

This core list of cognitive activities (Table 1, column 4) demonstrated by students at each level of Bloom's Taxonomy was generated from an analysis of 200 transcribed student-attempted Destination Math problems (N=200). Bloom's Taxonomy of educational objectives was used to identify the highest level of cognitive activity demonstrated by students while using Destination Math. Two hundred analyses of students' cognitive activities while using Destination Math were organized by activity-type: test questions, tutorial problems, practice problems, and workouts.

## Students' Levels of Cognitive Engagement While Working on Destination Math Test Questions

Figure 1 shows that for over 50 percent of the test problems analyzed (N=156) students were engaged in the most complex and abstract level of cognitive activity, represented by Level 6 on Bloom's Taxonomy. Thirty-two percent of the remaining problems were completed by students who demonstrated analysis and synthesis of mathematical concepts, represented by Levels 3 and 4. Only 6 percent of test questions analyzed showed that students attained no higher than Level 2 (LOTS) on Destination Math test questions. Ninety-four percent of Destination Math test questions engaged students in HOTS.

***Figure 1: Taxonomic Analysis: Destination Math Test Questions***

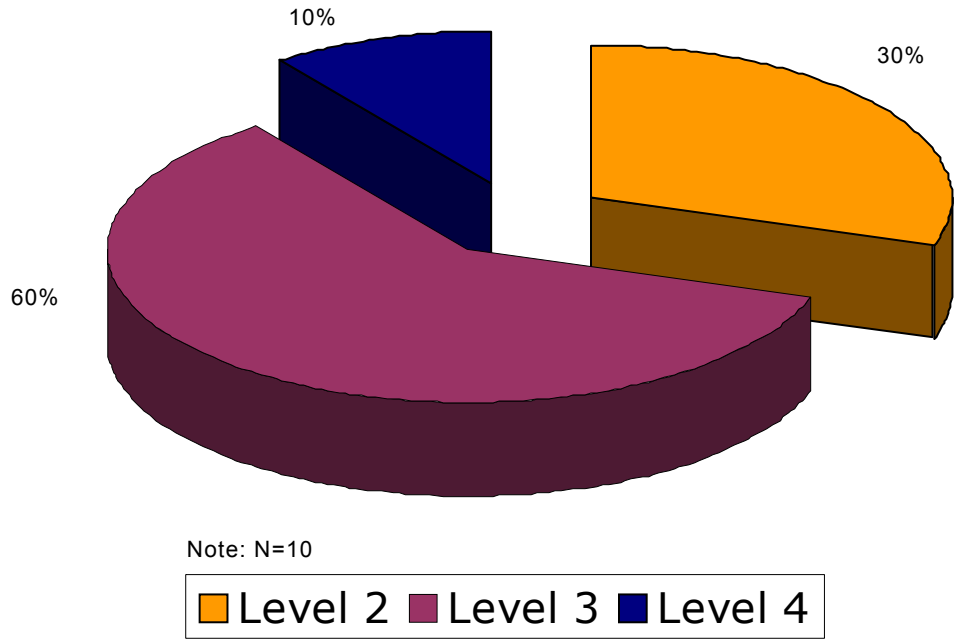



L1 = Knowledge
L2 = Comprehension
L3 = Application
L4 = Analysis
L5 = Synthesis
L6 = Evaluation

## Students' Levels of Cognitive Engagement While Working on Destination Math Tutorials

Figure 2 presents the analysis of 10 student-completed Destination Math tutorials (N=10). For the 10 math problems analyzed, students demonstrated comprehension (Level 2) of math concepts for 30 percent of problems, application (Level 3) of math concepts for 60 percent of problems, and analysis (Level 4) of math concepts for 10 percent of problems. Thirty percent of tutorial problems analyzed engaged students in LOTS, while the remaining 70 percent of problems engaged students in HOTS. This analysis reflects the dual purpose of Destination Math tutorials in providing scaffolds for student recall and rehearsal of math concepts, and the application of concepts to novel problems. Note that the transition from lower-order thinking to higher-order thinking is supported in this environment, thus students who need to learn in a very concrete or strictly sequenced manner are supported as they begin to develop more robust mathematical understandings.

***Figure 2: Taxonomic Analysis: Destination Math Test Tutorials***

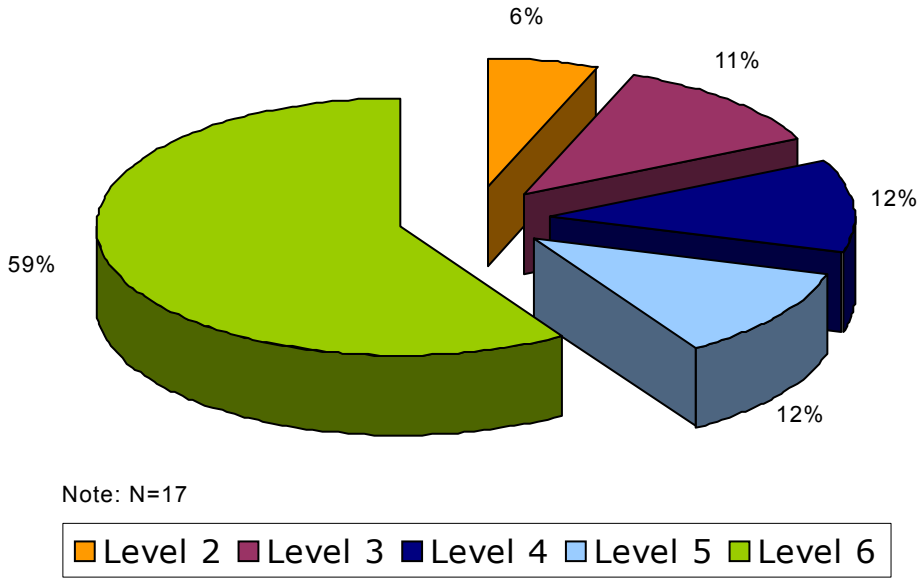



L1 = Knowledge
L2 = Comprehension
L3 = Application
L4 = Analysis
L5 = Synthesis
L6 = Evaluation

# Students' Levels of Cognitive Engagement While Working on Destination Math Practice Problems

Figure 3 presents the analysis of 17 student-completed Destination Math practice problems (N=17). Figure 3 shows that of the 17 problems analyzed, 59 percent of these engaged students in the highest level of cognitive activity, evaluation. Only 6 percent of the problems analyzed indicated Level 2 (as the highest level of) student cognitive activity. The remaining problems were equally distributed across Levels 3 (application), 4 (analysis) and 5 (synthesis). Ninety-four percent of practice problems analyzed engaged students in HOTS. Figure 3 suggests that the Destination Math practice problems provide opportunities for students to extend their engagement with math concepts beyond the opportunities for practice and preliminary application provided in Destination Math tutorials. As such opportunities are engaged in, students acquire a more adaptive grasp of mathematical concepts, one that better lends itself to transfer to other contexts.

***Figure 3: Taxonomic Analysis: Destination Math Practice Problems***

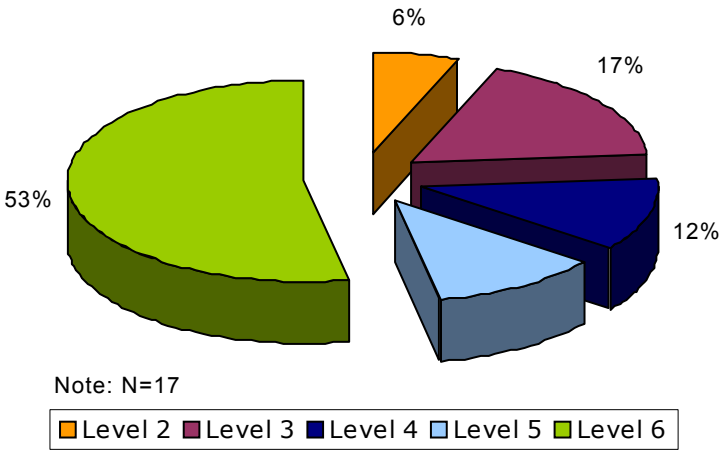



L1 = Knowledge
L2 = Comprehension
L3 = Application
L4 = Analysis
L5 = Synthesis
L6 = Evaluation

## Students' Levels of Cognitive Engagement While Working on Destination Math Workouts

Figure 4 presents the taxonomic analysis of 17 student-completed Destination Math workout problems (N=17). The distribution of completed student workout problems across cognitive activity Levels 2–6 is similar to the distribution discussed in Figure 3, for Destination Math practice problems. Figure 4 shows that 53 percent of problems analyzed engaged students in the highest level of cognitive activity, evaluation. Levels 4 and 5 were the highest levels of cognitive activity demonstrated by students for 24 percent of problems analyzed. Seventeen percent of students demonstrated application of math concepts learned (Level 3) as the highest level of cognitive activity. Only 6 percent of problems analyzed indicated Level 2 (as the highest level of) student cognitive activity. Figure 3 shows that, similar to the analysis of student practice problems, students demonstrated HOTS for 94 percent of workouts analyzed.

***Figure 4: Taxonomic Analysis: Destination Math Workouts***




L1 = Knowledge
L2 = Comprehension
L3 = Application
L4 = Analysis
L5 = Synthesis
L6 = Evaluation

## Conclusion

While many traditional text-book driven math lessons still engage students' thinking at the lower levels of Bloom's taxonomy, research has shown that students remember more when they have learned to think about mathematical concepts at the higher levels of the taxonomy. Researchers, educators, and policy makers have consistently argued that higher-order thinking skills are essential and must be taught in schools. This research has shown that Destination Math scaffolds the transition from LOTS to HOTS for students by providing opportunities for recall and rehearsal of math concepts in tutorials, and opportunities to apply and extend concepts learned in test questions, practice problems, and workouts. This research supports the conclusion that developing students' HOTS or critical-thinking skills is a compelling rationale for the use of Destination Math in schools.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