

The Motivational Effects of Using a Computer-Based Tutorial vs. a Traditional
Instruction Method for Learning How to Use an Elementary Level Mathematics Game

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By

Christopher Roth

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DATE

Dr. Russell Kahn
Thesis Advisor

Dr. Kathryn Stam
Second Reader

ABSTRACT

The purpose of this project was to develop and evaluate a computer-based tutorial to educate students on how to use an elementary level mathematics game. The emphasis of the tool was based on the cognitive learning principle of motivation, as described in Malone's motivation theory. The research explored the motivational effects of using the tutorial versus a traditional learning method, advantages and disadvantages to teachers and students, and improvements that could enhance the learning process. This qualitative case study employed post-testing, interviews, and referenced literary resources to collect and analyze data. Tutorial users scored ten percent higher on the post-test than the instruction sheet users. Advantages of the tutorial included user control, visual references, and assistance for learning disabilities. Disadvantages included loss of human interaction and the preparation and development process. Character development (fantasy), increased audio/video combinations, and more challenging elements were cited as areas for increasing motivation.

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Introduction

The National Assessment of Educational Progress (NAEP) reports that while elementary mathematics and reading scores have previously shown gradual improvements, there has been stagnation between 2007 and 2009. Educators face many challenges in developing the skills and aptitude of their students. The classroom should present an enriched learning environment that provides a stimulating experience. Teachers are constantly looking for ways to improve the performance and knowledge of their students. The educational resources used to instruct learners should be continuously monitored and evaluated for effectiveness with a goal of increasing understanding and reducing the frustration encountered by both students and teachers.

Innovations in technology can be advantageous to teachers who face such issues. In 2000, the NAEP specified that the ratio of students to computers with internet access in public schools was 7:1. That statistic has significantly shifted to 3:1 in 2008, showing the growth of these resources. Teachers can use such technologies to their benefit as they provide a wealth of opportunity for learning. Computer-based tutorials are one such tool that can be used in an academic environment. A tutorial is a program that helps users learn how to operate an application or provides a presentation of content. These tools transcend traditional instructional methods to assist users in the learning process while aiming to ensure understanding. The innovative quality and structure of tutorials can offer a greater opportunity for learning material effectively.

For this project, a model of an educational game that teaches basic mathematic functions was produced as an original representation to students and teachers for which

they had no prior experience using. A tutorial was created to instruct users on how to operate this program and offer a modern, structured approach to learning new material. Elementary school teachers were divided in to two groups. One group was provided with the tutorial, while the other received a basic instruction sheet that they reviewed and used in the classroom. A post-test and interview was conducted to understand and compare the motivational effects of these methods and their value in such an educational setting.

Literature Review

Mathematic Educational Games

Educational games are a valuable resource for young learners due to their motivational quality. They encourage “learners to study material they might not otherwise choose to study at all” and “spend more time with the program than they would if it did not use the game methodology” (Alessi & Trollip, 2001, p. 271). “While multimedia tools have been slow to penetrate instructional methods in some subjects, the math world is bursting with tales of teaching technologies that visualize concepts, adapt to students' strengths and weaknesses, and align with state academic standards” (Quillen, 2011, p. S4). Integrating basic mathematical concepts into gaming is an enjoyable way for children to learn and enhance the educational experience. However, these games “are only one type of classroom activity. To maintain their motivational value, the teacher should not overuse them. As with any classroom activity, teachers should monitor and evaluate the effectiveness of games as part of the instructional curriculum” (Shaftel, Pass & Schnabel, 2005, p. 25).

A research study on instructional games conducted from 1963 to 1991 showed that these activities are more likely to have beneficial effects when they focus on precisely defined content or require drill and practice, such as in mathematics (Randel, Morris, Wetzel, & Whitehill, 1992, p. 265). These games are used to support the learning of basic arithmetic and problem-solving skills. Fengfeng and Grabowski's (2007) study on the effects of game play on fifth-graders' math performance revealed that these activities promoted test-based achievement and played a considerable role in positive learning outcomes (p. 256). Educational computer games can be "powerful mathematical learning tools with great motivational appeal and multiple representations of learning materials" (Fengfeng & Grabowski, 2007, p. 249).

Tutorial Creation

The process of tutorial creation is extensive and should take many factors into account. These technologies are employed in the classroom to ensure that program operation and general principles are fully understood reducing the frustration encountered by students and teachers alike. Creating these tools requires time management, planning, preparation, and attention to positive feedback (Zdravkovic, 2010, p. 61). An examination of learning via online tutorials conducted by Lo and Dale (2009) discovered that these tutorials should incorporate active and collaborative learning while clearly presenting student objectives in an outline. Their further review of one case study concluded that "breaking down instruction tutorials into manageable sections (modules), while remaining linear and allowing for the step-by-step acquisition of skills, prevents the user from becoming overwhelmed with information" (p. 151).

A designer should think about issues such as staffing, funding, target audience, objectives, educational strategy, content, design, length, evaluation, and updating prior to the creation process. Electronic tutorials should present strategies such as active learning through the purchase and use of tutorial creation software and developing a formal tutorial plan (Plumb, 2010, p. 50). Before purchasing a software product, factors such as cost, functionality, features, and vendor support should be considered (Kuzma, 2010, p. 54). The development process should include attention to target audience, language, navigation and layout, instructional load, help features, instructional depth and user accountability (Holliday, Ericksen, Fagerheim, Morrison & Shrode, 2006, p. 200).

Storyboarding is an important procedure for design and structural purposes. Having visual outlines help the creator locate and organize the main elements and sections of a tutorial. An inventory of materials including screen captures, images, text, file names, formats, and locations should be manufactured. The storyboarding method lets the designer begin developing an audio script to complement the visuals so the program can take shape. This offers easy organization and time management for the construction and update processes (Plumb, 2010, p. 52). When information is constructed well, the aesthetic quality is enhanced which makes such programs appear to be “easier to use, are more readily accepted and used over time, and promote creative thinking and problem solving” (Lidwell, Holden, & Butler, 2010, p. 20).

Perception and Attention through Tutorials

The learning process begins with attention to and perception of information in the student’s environment (Alessi & Trollip, 2001, p. 21). If learners can repeat material and

work at their own pace, the information is more likely to be retained. “Information presented too quickly or too slowly increases the difficulty of both attention and perception” (Alessi & Trollip, 2001, p. 21). The instructional load, or time to complete a module or section, is particularly significant (Holliday et al., 2006, p. 200). Tutorials should generally maintain a relatively short length, or be broken into multiple components in order to maintain user’s attention. Tutorials work best as smaller files since they load faster and are easier to edit and update (Plumb, 2010, p. 62).

The ease of perception in tutorials can also be illustrated through volume control, audio clarity, and the level of detail used in images. Video features should avoid erratic motions, skipping frames, and syncing problems that are characteristic of high quality digital material (Plumb, 2010, p. 61). Differences and changes such as various text size, color, fonts, and dynamic techniques like motion video attract and maintain attention (Alessi & Trollip, 2001, p. 21).

Simplicity is important to creating effective tutorials. The design should focus on visual elements rather than text, relevant images, and be easy to read with large font sizes and high contrast (Plumb, 2010, p. 52). The placement of this information also determines whether users notice and think about it. “Designers generally place more important visual information near the center of a screen and secondary information, such as directions, towards the edges” (Alessi & Trollip, 2001, p. 21).

Encoding through Tutorials

In order to create an atmosphere where students are going to fully understand certain concepts, teachers will need “to bring in tools beyond pencil and paper” (Quillen,

2011, p. S5). The cognitive learning principles “reflect most of what is important when designing and evaluating interactive multimedia” (Alessi & Trollip, 2001, p. 20). The process of encoding means the information learned must be converted into an arrangement that can be stored in the brain. “Dual coding suggests that learning is enhanced when complementary information codes are received simultaneously... and... is best facilitated by a combination of complementary visual and auditory information” (Alessi & Trollip, 2001, p. 22). Educators who utilize tutorials should not be anxious about creating or using this technology. Designing these tools should be a “creative process bringing together audio, video, and much more” (Plumb, 2010, p. 62).

Memory and Comprehension through Tutorials

Tutorials can be extremely resourceful in expanding a student’s memorization of material by providing structured information and an opportunity for the clarification of concepts that require understanding (Davidovitch, Schacham, & Ribakov, 2009, p. 1022). In order to enhance the retrieval of information a learner has perceived and encoded, the memory principles of organization and repetition are very important. “Information is remembered better and longer when it is organized, when organization is imposed upon it, or when the learner is made aware of the organization” (Alessi & Trollip, 2001, p. 22).

Singh and Haileselassie (2010) conducted a study on how online tutorials used in the classroom can help develop problem-solving skills. Three separate groups of students were presented with a problem and supplied with either textbook sections relevant to the material, a textbook solution manual, or an interactive tutorial. The tutorial was created to

deliver “a structured approach to problem solving and promote active engagement while helping students develop self-reliance” (p. 43).

Comprehension of information is reflected when learners know when to apply principles and demonstrate their correct application (Alessi & Trollip, 2001, p. 23). The group utilizing the tutorial displayed a “pattern of reasoning... significantly better on an average than the other two groups” (Singh & Haileselassie, 2010, p. 48). This exhibited that learners “must not only store and retrieve information, but be able to classify it, apply it, evaluate it, discuss it, manipulate it, teach it to other people, and so on” (Alessi & Trollip, 2001, p. 23). A survey of the class showed that most students found the tutorials beneficial noting their interactive and self-paced aspects. This tool provided an organizational approach that successfully enhanced the memory and comprehension of learners.

Active Learning through Tutorials

The cognitive learning approach emphasizes active learning because “it assumes people learn not only by observing but by doing” (Alessi & Trollip, 2001, p. 24). Tutorials are useful for subjects that require more attention than a classroom lecture can offer (Davidovitch et al., 2009, 1022). McCourt and Carr (2010) searched for ways to improve engagement and retention in their students as they were failing to progress in courses (p. 63). Tutorials were presented in this case as an alternative method of instruction since lectures do not suit all students learning styles. A successful tutorial should have interactive qualities and make the user feel positive about the experience (Gareis, 2007, p. 465).

The effectiveness of computer tutorials used in a mathematics literacy course was explored by Frith, Jaftha & Prince (2004). Computers were found to “provide fundamentally new interactive types of learning environments suitable for exploration and experimentation” (Frith et al., 2004, p. 161). In many instances the computer tutorials used by students were more effective than the lecture room interaction in conveying concepts. These findings demonstrate the “importance of interactivity in multimedia programs, as interaction not only maintains attention, but helps create and store new knowledge and skills, and facilitates comprehension” (Alessi & Trollip, 2001, p. 24).

Motivation through Tutorials

Motivation is an important principle that should consider design elements such as challenge, control, curiosity, and fantasy. Attention needs to be grabbed early and sustained throughout a lesson. Maloy, Edwards and Anderson (2010) examined the implementation of a web-based mathematics tutoring system for fourth grade students and their teachers. The program uses four child friendly characters, also known as coaches, to encourage users to spend more time working through math problems strategically, improve test-taking skills, and build self-confidence (p. 82).

Satisfaction can be achieved through positive support following progress, encouragement in times of difficulty, and fairness through evaluation of learner actions (Alessi & Trollip, 2001, p. 27). Prior to its application, the students were informed that “being successful with math problem solving, is the same as being successful in sports, dance, music, or video games - you need focus, energy, practice, and support. Good math thinkers learn from good math coaches” (Maloy et al., 2010, 85). A pre and post-test of

equal difficulty were administered to determine any growth in knowledge. An increase of about twenty-six percent in test scores was achieved showing how motivational factors can enhance the learning process.

Tutorial Evaluation

An analysis on the effectiveness of tutorials and whether students and educators find them to be valuable is particularly important. “Various sets of guidelines, criteria, and principles exist for evaluating usability and effectiveness of educational software and web-based learning environments” (de Villiers, 2007, p. 465). After the incorporation of coursework concepts into online tutorials in Tallmadge and Chitester’s (2010) study, “instructors noticed an improvement in the ease with which students integrated the foundation principles from the tutorials into learning new concepts” (p. 5). From pre-test to post-test, the average score increased thirty-three percent. The majority of the group found the tutorials beneficial and would recommend them for use in future classes.

Seal, Przasnyski, and Leon’s (2010) examination on levels of interactivity in tutorials showed that “excessive interactivity increased the cognitive load for students and hindered their learning by making it difficult for them to consolidate concepts, integrate previous knowledge, and create meaningful mental models of the process” (p. 75). Students were categorized into groups utilizing materials with no interactivity or low to medium levels via tutorial. The low interactivity group exhibited the greatest improvement in scores, while the other two groups showed no significant difference. Although a tutorial can be a successful learning tool, simplicity can go a long way in exhibiting that less is more.

The integration of video tutorials into mathematics courses has shown that the design and use of these resources help students use computer software and aid in time management and skill practice issues. Evaluations of these primarily visually-based materials indicate that:

Teachers at all levels of the education hierarchy with software skill development needs will find similar tutorials helpful for their situations... and... designing a tutorial will provide students a reference for their technical questions and free the instructor to focus on the more important aspects of the course including concept building and problem solving. (Ellington & Hardin, 2008, p. 117)

Educators that provide technology driven learning materials in addition to standard personal classroom interaction give their students an extra advantage. In the case of the web-based mathematics tutoring system implemented by Maloy et al. (2010), an evaluation indicated that a combination of online and face-to-face learning activities show evidence of the development of a problem solving mindset among students. Those who utilized both activities progressed by demonstrating a thought process and strategy when solving math problems in class or on tests (p. 88).

Various evaluation strategies such as informal interviews and questionnaires including both qualitative and quantitative questions can help determine whether a tutorial is helpful, clear, and of appropriate length (Plumb, 2010, p. 53). One examination of online tutorials employed surveys upon completion of the program to uncover positive and negative feedback. Students felt that tutorials were helpful in explaining concepts and presented a convenient method of guidance. However, the length, rigidity, and lack of

creativity along with personal time constraints were common downsides. These observations displayed that educator's:

Cannot assume that students will necessarily take advantage of technology and module enhancements, and a return on investment needs to be considered before spending a great deal of time and money on tutorials that may not serve a vast majority of the students. (Kuzma, 2010, p. 59)

While there will naturally be undesirable outcomes when any program such as a tutorial is measured, these evaluations can offer a wealth of constructive ideas for updating and improving the design.

Research Questions

The purpose of this project was to develop and evaluate a computer-based tutorial, with emphasis on the cognitive learning principle of motivation, to educate teachers and students on how to use an elementary level mathematics game. The research questions that guided this study are as follows:

1. How is motivation affected by those who used a computer-based tutorial versus a traditional instructional method for learning how to use an elementary school level mathematics game?
2. What do students and teachers perceive as the advantages and disadvantages of using computerized tutorials for learning in the classroom?
3. How can the tutorial be improved to increase motivation in students?

The primary question under investigation was: How is motivation affected by those who used a computer-based tutorial versus a traditional instructional method for learning how to use an elementary school level mathematics game? The interactive characteristics of tutorials are useful for subjects that require more attention than a classroom lecture can offer. The areas of cognitive learning theory such as perception and attention, encoding of information, memory, comprehension, active learning, and motivation are important to the design and evaluation of multimedia programs and the success of using them in academic environments. Malone's motivation theory suggests that challenge, curiosity, control and fantasy are factors that contribute to motivation. Intrinsic motivators such as visual techniques, exploratory environments, personal control, and encouragement can help learners consider a certain type of instruction as fun. For this study, an analysis was conducted through a post-test to observe which method of learning illustrated a better transfer of knowledge about the information being taught. Tutorials are presented as an alternative and motivational method of instruction since lectures do not suit all students learning styles.

A secondary question explored was: What do students and teachers perceive as the advantages and disadvantages of using computerized tutorials for learning in the classroom? Many factors can affect the implementation of these tools in the classroom such as cost, convenience, and creativity. Teachers cannot predict if students will benefit from technology developments and need to consider the advantages and disadvantages of taking on such a project before spending a great deal of time and money. An exceptional design with clearly defined objectives for the student will help make tutorials a positive

learning experience. A tutorial can give students a reference for their questions which allows the instructor more time to focus on other important parts of the curriculum.

It was important to conclude this study by asking the question: How can the tutorial be improved to increase motivation in students? While skillfully developed tutorials can help maintain attention, create and store new knowledge, and facilitate comprehension, there is always a necessity for evaluation and improvement. An analysis of the effectiveness of tutorials and whether students and educators find them to be useful is particularly important. Assessment strategies such as interviews can help the creator understand whether a tutorial is helpful and obtain constructive criticism so that the information can be restructured to improve the design. The positive and negative feedback collected from this study was analyzed to identify what the users found valuable in their learning experience and demonstrate if there was a need and desire for tutorials in the classroom.

Project Development

The computer-based tutorial created for this project reflected on the cognitive learning psychology principle of motivation (Alessi and Trollip, 2005) and various universal design principles (Lidwell, Holden, and Butler, 2010). The focus of the tutorial was on instructing students and teachers how to operate an educational game geared towards learning elementary level mathematics. The tutorial was developed using primarily Microsoft PowerPoint and Camtasia Studio. The prototype for the educational game, entitled *Math Mind*, and a text-based instructional sheet were created using

Microsoft Excel. The sheet was presented for comparison as a traditional learning method in the classroom. The tutorial can be downloaded and viewed at <http://goo.gl/mIbyk>.

PowerPoint, Excel, and Camtasia were chosen with emphasis on cost, usability, objectives, and design features. PowerPoint has the ability to produce and present rich, interactive content which is a central characteristic of multimedia design. An added benefit of this program is that the Microsoft Office software package, which includes Excel, can be purchased in editions for students and teachers at an educational discount. Camtasia is screen recording and video-editing software that can be used to create videos for training and teaching information. Camtasia offers a free thirty-day trial to users, which is helpful to those who would like to test out the functionality of the program before buying. Both products also offer extensive help and tutorials right on their websites.

The development process included attention to the target audience, motivational factors, navigation and layout, instructional load, and aesthetic qualities. The tutorial was categorized into easily accessible sections or modules. This provided a step-by-step acquisition of knowledge to prevent information overload on part of the user. Learners were able to repeat material and work at their own pace so that the information was more likely to be retained. The time to complete each section was relatively short to maintain user attention. Page controls were incorporated in the form of buttons that had consistent placement. Iconic representation was used for navigational cues that were easy to recognize and remember. The forward and back progression was untimed and controlled by the user. Opportunities for review were generated with this type of paging and also through structured menus of information.

The design emphasized simplicity and included visual and text elements with legible fonts and complementary color contrasts. The look of the tutorial gave the impression that it was easy to use and visually stimulating to enhance its aesthetic-usability effect. The information displayed alignment cues to show cohesion in the design. Color was used somewhat conservatively with visually appealing combinations. Highlighting techniques were implemented to bring attention to important elements of information. Procedural help was provided at the start of the tutorial and could be accessed at any time through a consistently placed button on the navigation toolbar.

A combination of visual and auditory information was used simultaneously through motion video to enhance learning through dual encoding and attract and maintain attention. The material was structured and organized with the ability to repeat the learning process to allow for memorization. The users were not only able to observe the tutorial but be actively a part of the process with user navigation control in an interactive environment. Encouragement and motivational elements were used to ensure that confidence and satisfaction were achieved through the use of this program.

Methods

Teachers encounter problems on a daily basis with student retention and progression through basic classroom instruction. Finding new techniques to resolve these issues can be addressed through modern advancements in technology. Technology-driven assistance materials can be a valuable motivational resource for learning especially in an elementary school setting. The foundations for which these tools are created are rooted in

cognitive learning and universal design principles. The goal of this study was to demonstrate that computer-based tutorials are extremely valuable for the motivation and knowledge they provide to students.

The review of literature for this project as well as prior experience influenced my approach for this study. I have personally created a computerized tutorial which served as an alternative to a text-based manual for learning to use a hotel reservation system at my previous job. While both methods were beneficial to the users, the innovative and technological approach was well received by the department who utilized the program. Although I did not acquire detailed data on the experience and opinions of the users in this case, I believe the positive feedback received has helped conceptualize this research. I expected to find that the computer-based tutorial would be more motivational and valued than the traditional learning method based on my prior experience and the review of literature. Most of these studies revealed that tutorial applications showed an improvement in usability or grading and received positive feedback from students. However, none of these biases will change any opposing conclusions reached in the data.

This research involves a qualitative case study that provides an in-depth description and analysis of a bounded system. The bounded system in this case is a group of educators who teach mathematics at an elementary school in Queens, New York. The study includes an inductive process to build concepts about the topic at hand. In this case, I, as the researcher, was the primary instrument of data collection and analysis. This type of study was selected because there was a limit to the number of people to be interviewed and a finite time for the process to be completed. There were eight teachers involved in the interview process, with one-hundred and forty-five students participating in the

preceding post-tests. Three male and five female teachers, ranging in ages from thirty to forty-eight, participated in the study.

The sample selection for this study included nonprobability sampling, particularly purposeful in order to understand and gain insight from those in which the most could be learned. The type of purposeful sampling was typical and convenient in nature; typical because it reflects the average person and situation with no extremes, and convenient because of its location and availability of participants. Each group of subjects was provided with either the computer-based tutorial or instruction sheet. Random sampling through a number generation program was used to determine which teachers would participate in which group. The participants were selected on a voluntary basis and signed a consent form to take part in the process (See Appendix A). This form was intended to make participants aware of the process and included information about the nature of the research, voluntary participation, protection of confidentiality, audio-recording device to be used during the interview, and my contact information for any issues or questions.

Participants were classified into two groups; instruction sheet users and tutorial users. The comparison of the learning methods implemented was evaluated with various strategies. Immediately following the initial use of the methods, users were assessed on their knowledge of the educational game. Since the game for which the tutorial was created is a prototype and not fully developed, questions were asked about the features of the model program explained in both the tutorial and instruction sheet.

Interviews were the primary research method, which involved a descriptive assessment of the perceptions and experiences of elementary school teachers. The interviews were semi-structured and guided by a list of flexible questions (See Table 1 on

the next page). The instructional method was referenced and available to review at the time of the interview. The questions varied for each group depending on the learning method implemented. Each interview was conducted in person with the potential for follow-ups if needed. The questions were meant to uncover the tutorial experience and perspective of using such a tool in the classroom. The process was tape-recorded, in addition to my taking notes.

I analyzed the transcribed interviews and fieldnotes using Microsoft Word, which allowed for a hardcopy and computerized backup. The analysis took place in conjunction with the data collection to avoid information overload. The strategy was inductive and comparative to find regularities and patterns on the data. Pieces of information that I found relevant were openly coded. This was followed by axial coding, where the open codes were grouped together. Categories were constructed from these codes, then reduced and combined so that the data was manageable and easy to share.

In order to increase the validity and reliability of my findings, I employed the strategy of triangulation by using the methods of data collection previously explained including interviews, post-testing, and referencing documents relevant to the topic. Respondent validation was used during the interview process to ensure that there was no misinterpretation of the participant's perspectives and identify any biases or misunderstandings on my part. Thoughtful review and self-examination were also considered throughout the data collection and analysis processes. To ensure that the data collected was unbiased; a non- participant teacher who has reviewed both methods took part in a pilot study and monitored the assessment in conjunction with me. This helped in

Table 1: Interview questions	
1.	What do you normally use computers for in the classroom?
2.	How did you control, or move through the program? (<i>Reference: Main Menu slide</i>)
a.	Did you follow a certain order or use the menu to look at different sections individually?
3.	Did all of the buttons make sense? (<i>Reference: toolbar on Main Menu slide</i>)
a.	Did you always know how to get to the next section or find help?
4.	How was the use of audio and video helpful to you? (<i>Reference: Settings slide with Camtasia video</i>)
5.	What information in the tutorial/worksheet stood out the most to you? (<i>Let user navigate through the tool</i>)
a.	What made this information stand out?
6.	What did you think about the question asked in the tutorial? (<i>Reference: Question slide</i>)
a.	Can you tell me about the tutorial's response to your answer? (<i>Reference: Response to Question slide</i>)
7.	Could you tell me about any challenges or difficulties you came across as you moved through the tutorial/worksheet? (<i>Let user navigate through the tool</i>)
a.	How did you handle these difficulties?
8.	What section of the tutorial/worksheet did you find the most helpful and least helpful? (<i>Let user navigate through the tool</i>)
a.	What made these helpful/unhelpful?
9.	What would you change in the tutorial/worksheet? (<i>Let user navigate through the tool</i>)
a.	What other instructions would you include?
b.	What other sections might you add? (<i>Reference: Main Menu slide for b-d</i>)
c.	What colors might you change?
d.	What pictures would you add or remove?
e.	What video or audio might you add? (<i>Reference: Games slide with Camtasia video</i>)
f.	What other help would you include? (<i>Reference: Help slide</i>)
g.	What did you think about the turtle character? (<i>Reference: Introduction slide</i>)
10.	What would you consider the advantages and disadvantages of using tutorials in the classroom?

eliminating the opportunity for any exclusion of data that would be in opposition to my views.

Pilot Study

A pilot study was conducted with one teacher who helped in organizing the research at this particular school in Queens, NY. This process was helpful in a number of areas. As expected, there were a few revisions that were made to the tutorial including navigational cues, highlighting, and text issues. The full interview was completed and some questions were revised or deleted based on the notion that they were slightly repetitive. The same teacher took part in a peer review and examination throughout the process as a strategy for increasing the validity and reliability of the findings. All post-test scores were checked for accuracy so that there was no misrepresentation of the data.

Data Analysis

The data revealed a variety of motivational effects as experienced by the users of the selected methods in the classroom. After eight teacher interviews and post-test evaluation, the emergence of new ideas was limited. This suggested saturation of the data.

The first research question asked how motivation was affected by those who used a computer-based tutorial versus a traditional instructional method for learning how to use an elementary school level mathematics game. Participants were divided into groups that used one of these methods, and a post-test followed that included nine questions

about the information reviewed. On average, the tutorial users scored approximately ten percent higher on the post-test than those who used the instruction sheet. The results indicate that students showed slightly higher levels of motivation from using the tutorial.

On average, tutorial and worksheet users scored highest on question numbers 2 and 7. Both of these questions incorporated visual images in the answer choices. Tutorial users scored well on questions that involved modules with audio/video features. The lowest scoring question in both groups was number 5, which covered material about the *Help* section. The *Help* module in the tutorial was a more basically structured and less interactive section. The post-test scores are recorded below in Table 2. A list of the questions asked can be found in Appendix C.

Table 2: Post-test scoring			
Question #	Tutorial users	Worksheet users	Average of all users
1	(71 users)	(74 users)	(145 users)
2	95.77%	94.59%	95.18%
3	83.10%	64.86%	73.98%
4	80.28%	74.32%	77.30%
5	70.42%	67.57%	69.00%
6	94.37%	70.27%	82.32%
7	98.59%	91.89%	95.24%
8	95.77%	85.14%	90.45%
9	91.55%	87.84%	89.69%
10	84.51%	68.92%	76.71%
Total Average	88.26%	78.38%	83.32%

**Percentages reflect correct answers*

The second research question asked what students and teachers perceive as the advantages and disadvantages of using computerized tutorials for learning in the classroom. Thematic analysis yielded five themes: *control*, *visual references*, *learning disabilities*, *human interaction*, and *preparation/development*.

The *control* theme refers to the level of choice and power given to the user when operating the program. A second grade math teacher, Gabrielle, saw this as an advantage to the students learning process as “Letting the children work through such computer programs on their own gives them a sense of empowerment.” The participants expressed a fondness in the ability to move throughout the tutorial and work at their own pace. A prominent feature noted was the separation of sections in the menu which allowed for easy reference of individualized material.

Visual references were the most notable advantage revealed from the tutorial analysis. Teachers indicated that students were particularly stimulated by the animation techniques, audio and video combinations, and picture representations. Rocky stated:

My students are always excited when I incorporate visual materials into the lesson. The tutorial reminded me of an instance where we were learning some science terms. I used flash cards with pictures, which seemed to get more of a response than reading about the solar system in a textbook. I think a tutorial would be helpful for topics like this where the kid’s associate visuals to gain some kind of understanding from the material being covered.

Other participants mentioned that the animation qualities drew some gasps and garnered the attention of students, which can be difficult to do at times.

One benefit of visual or graphic tools is the assistance they can provide to students with *learning disabilities*. Suzanne stated:

I have worked specifically with children who have ADD (Attention Deficit Disorder). You have to remember that these students get bored easily, so you need to have a variety of activities to maintain their attention. I can see where a

program like this would be helpful. It's always hard to keep all students engaged but changing up your teaching style once in a while can get students excited about a topic, especially those with ADD, or ADHD (Attention Deficit Hyperactivity Disorder).

The hands-on and active participation established in the tutorial were recognized by users. Fawn mentioned, “Students with ADD, Autism, and hearing impairments get a sense of personal achievement or satisfaction from being actively involved in the learning experience. Tutorials could help children who have difficulties with listening, responding, following instructions, processing information, anxiety, etc.”

The most noteworthy disadvantage of incorporating tutorials in the classroom was the theme of dealing with the possible loss of *human interaction*. Most teachers expressed dissatisfaction with the idea that these tools could potentially “take over” as primary learning resources in the future, leading to socialization issues. John said:

Technology has many advantages, but don't forget people did just fine without it in the past. Using programs like these excessively can lead to a loss of communication and interactive skills. Children don't come to school just to learn about math and science; they come to learn about socialization and conflict resolution. We can't completely forget those aspects. If we continue at this rate, no one will personally interact anymore; everything will be done by computer.

The participants thought that finding some middle ground or combination of these tools in addition to traditional instruction might be the best avenue for education in the classroom.

The final theme conveyed the difficulty of *developing* and *preparing* such resources. One question that came up numerous times was how long it took to create the program. The teachers, for the most part, felt that bringing in outside materials can be extremely helpful, but they have a great deal on their plate already without having to worry about producing additional resources. Betty said, “I am pretty tech-savvy, but I wouldn’t have time to make something like this every week for a lesson. People forget that teachers work around the clock whether it’s grading or preparing lessons, among other things.” The participants noted that locating tutorials or other technology resources would be a better possibility for use in the classroom, but the development process could be problematic.

The third research question asked how the tutorial could be improved to increase motivation in students. Thematic analysis yielded three themes: *character development*, *audio/video combinations*, and *challenge*.

In the teacher’s practice of the tutorial in the classroom, students desired greater *character development*. ‘Teddy the Turtle’ was incorporated into the program for motivational purposes, but the users felt he could play a bigger role. When asked about the changes that could be made to the tutorial, Jennifer mentioned:

The students had a lot to say about the turtle. They thought it would be ‘cool’ if he talked or had a bigger part in the program. Some thought it would be nice if you could choose a character, dress it up, and pick its name or voice. There were many imaginative suggestions.

The points referenced in this theme showed a craving for more fantasy elements.

The second theme demonstrated a preference for more *audio/video combinations*. The teachers cited that students were most focused when it came to the modules including an embedded video. Suzanne said, “I noticed some navigation issues, and I think if each section had a video it would be better, as opposed to constantly clicking around.” As previously mentioned, the post-test revealed that the questions surrounding material covered in the videos received the highest scores. John stated, “The videos were a nice touch. I use videos like this for a number of assignments. Sometimes, I think the students are tired of listening to me and get more encouragement from someone else talking for five minutes.”

The *challenge* theme refers to the level of difficulty and question and answer responses. The participants felt that some students were not challenged by the level of material covered in the tutorial. The question/response section could have included more questions or a scoring system to create an additional element of motivation. Rocky stated, “I liked how the response let you review why you were wrong, but it could have been a bit better. Maybe, using the students name or being a little more encouraging could have helped.”

Discussion

The analysis of data revealed that visuals, audio, video, and animation were prominent advantages to the students using the tutorial. Post-test questions that incorporated media into the question and or information explained in the tutorial produced the best results. Users of both learning methods scored highest on questions that

incorporated visuals into the answer choices. The audio/video features built into various modules of the tutorial illustrated a high level of information retention. The lowest scoring questions contained information from primarily text-based and non-interactive modules. Improvements could be made to the tutorial by enhancing the material provided in these areas. Since audio/video and visual imagery demonstrated positive motivational effects, these elements could be utilized in sections that exhibited lower scores.

One of the major disadvantages of the tutorial expressed by teachers was the possibility that the use of these technologies may reduce human interaction and communication skills. However, educators need not be excluded and should be directly involved in the process. Future tutorials could integrate question and answer sections with the ability for teacher interaction. When students get an incorrect answer or need assistance, teachers could be notified through a special button placed on the navigation toolbar. The teachers can then guide students through issues and explain any errors, which improves the program by incorporating everyone in the procedure and adding the element of human contact.

Conclusions and Future Research

Many academic institutions encounter problems with student motivation through basic classroom instruction and lectures. Finding new techniques to resolve these issues can be addressed through modern advancements in technology. Tutorials can be advantageous when provided as an assistance material for understanding concepts such as learning to use educational games. The foundations for which these tools are created are

rooted in cognitive learning principles. Tutorials can provide an innovative way of helping users learn a process or function while aiming to ensure understanding.

It is important to note that due to the small size of this study and sample, other researchers may want to test any conclusions developed in this project in additional grade levels and disciplines. The data showed a number of positive motivational effects as experienced by the participants. Tutorial users not only experienced a higher score on the post-test, but exhibited how visual references can be extremely useful to the learning process. Animation and audio/video combinations can be helpful to students, especially those with learning disabilities. Tutorials provide an active learning environment that engages students and increases attention. The user control displayed how actions can have ‘powerful effects’ that can be very motivating as explained in Malone’s motivation theory (Alessi & Trollip, 2001).

Malone’s theory also covers the factors of challenge and fantasy in motivation. Young students find elements of fantasy encouraging especially when there is some imaginary context involved. In this case, the further development of the character was desired. The participants wanted more question components that offered difficulty options, which would have made the process more challenging, therefore increasing motivation. The intrinsic motivators such as using gaming and visual techniques, exploratory environments, and personal control contributed to the positive aspects of the program.

Participants agreed that technology can enhance traditional methods of learning but cannot replace the human touch. A tutorial does not offer the social and communicatory skills that are necessary to human interaction. The design and

maintenance of tutorials is an extensive process that requires a great deal of planning and preparation. It is not always feasible for a teacher to create such resources, but locating already developed materials is a benefit.

The results showed the advantages and disadvantages of tutorials, explored motivational factors, and delved into possibilities for increasing motivation. Future research would best be explored in the area of children with learning disabilities. It was clear that these tools can be valuable to the learning process for students with ADD, ADHD, hearing impairments, and autism. A similar study on the effect of tutorials and traditional instruction with the testing of both methods might be very helpful in determining what approaches are best suited for students with each type of learning disability. Any attempt to improve education rates is a worthwhile undertaking. Computer-based tutorials can be a valuable resource for the assistance and knowledge they provide to both students and teachers.

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Appendix A: Consent Form

You are being invited to participate in a research study. This authorization is requested in part to fulfill requirements of the State University of NY Institute of Technology's Human Subjects Research Review Board as well as state and federal regulations regarding the use of human subjects in research. Please take a few moments to read the explanations to help you decide whether you should/should not participate.

I am a student at State University of New York, Institute of Technology at Utica/Rome in the Information Design and Technology graduate program. I can be reached at **516-301-0358** or rothc@sunyit.edu, and would be happy to answer any questions or concerns that you may have about the project.

The research involves a qualitative case study that will be used in my master's thesis project. This study will explore the motivational effects of using a computer-based tutorial vs. a traditional instruction method for learning how to use an elementary level mathematics game. The data collection methods will include a post-test and interview. All participants will be randomly divided into two groups. One group will use the computer-based tutorial for learning while the other will use the instruction sheet. The interview sessions will be audio-recorded. These semi-structured interviews will include approximately twelve questions that will be asked depending on the learning method used. The method will be referenced and available to look over at the time of the interview.

I would like to reassure you that as a participant in this project you have several rights:

- Your participation in this study is entirely voluntary.
- You are free to decline to answer any question at any time.
- You are free to withdraw from the study at any time.

I will do my best to secure your confidentiality by employing a number of practices. I will be the sole source of access to the collected data and identifiable information such as names, phone numbers, school name, and address, which will be securely stored in a computerized document with password protection. The use of unique codes will be assigned and used to decipher participants on data documents such as post-test result sheets and fieldnotes. A document that associates these codes to the participants identifying information will be kept in a separate, locked location that can only be accessed by me. Portions of interview statements used in the final write-up will use pseudonyms to keep your identity confidential to the reading audience. At no point will I share any form of communication that is collected with the public unless it includes any plan or thought to inflict harm on an individual, which will then be reported to the proper authorities.

Copies of the final publications will be supplied whenever possible and as requested.

I would be grateful if you would sign this form to show that you have read its contents and agree to participate in the process.

_____ Signed

_____ Printed

_____ Dated

Appendix B: Instruction Sheet

Learning how to use Math Mind

Math Mind is an educational game that teaches basic elementary mathematic functions. *Teddy the Turtle* will guide you throughout the program.



Login

Sign into the program by clicking the **Login** button on the toolbar on the right side of the screen. If this is your first time using **Math Mind**, click **Create an account** and enter your information. If you are a returning user, enter your login name and password and press **Submit**. If you have forgotten your login name or password, click the link for **Login Assistance**. Upon login, you will be returned to the main menu where Teddy will provide you with an update on your recent progress.



Settings

The audio, text, and color settings can be adjusted in the toolbar on the right side of the screen. A red slash through an icon indicates that a feature is disabled. Click the **Level** tab on the main toolbar across the top of the screen to select the difficulty and type of mathematics problems you would like to work on. The level of difficulty ranges from one to five, five being the most difficult. Teddy will inform you of the most recent settings, which are highlighted and bolded in the selection area. You may also study subjects prior to level selection by clicking the **Review Material** link at the bottom of this page.



Games

Click the **Games** tab on the main toolbar. Your difficulty is determined by the level setting currently selected. You can adjust this prior to playing by returning to the **Level** tab. Press **Start** to begin the game. Questions will follow and you will hear and/or see the question based on your current settings. Type your answer and press **Enter** on the keyboard. If you are correct, a green check mark will flash on the screen and Teddy will say 'Yes'. If you are incorrect, a red X will flash on the screen and Teddy will say 'No'. After the final question is completed, you will be able to view your score. Review incorrect answers and study material or choose to **Play Again** at the current level. You can return to the **Main Menu** to adjust the level settings or use other features of the program.

Learning how to use Math Mind

(continued)

Worksheets

Click the **Worksheets** tab on the main toolbar. Your difficulty is determined by the level setting currently selected. Click on a sheet, then the printer icon to print a worksheet to work on at your own pace. Scroll through the sheets by clicking the green arrows. When you are ready to submit your answers, return to the worksheet and click **Submit**. Enter each answer next to the question, and click **Submit** to finish. Your grade will be shown on the screen. You have the option to review incorrect answers and study material. You can also return to the **Worksheets** section or **Main Menu**.



Scores

subject, or a progress chart by clicking on each option. Your **Total Score** will provide an overall and individual level average. Scoring by each subject will provide a high and average score per level and total average. The progress chart will show your overall average per month throughout the year. View other years by using the arrows at the top of the chart.

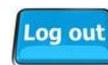


Help

Click the **Help** tab on the main toolbar. You have the option to review a tutorial about Math Mind, study the subject material, or review past assignments. Ask a question or search for information by entering text into the search field and clicking **Search**.

Logout

Sign out of the program by clicking the **Log Out** button on the toolbar on the right side of the screen. You will receive a goodbye message to ensure that you have been signed out.



Enjoy the game!



Appendix C: Post-Test

1
Math Mind Quiz <i>Please circle your answer to each of the 10 questions below.</i>
<p>1) I used the following tool to learn about Math Mind:</p> <p>A) Tutorial</p> <p>B) Instruction Sheet</p>
<p>2) If you are in need of password assistance, click on:</p> <p>A) </p> <p>B) </p> <p>C) </p> <p>D) </p>
<p>3) Text and audio features are disabled when the buttons are:</p> <p>A) Bolded</p> <p>B) Marked with a red X</p> <p>C) Flashing</p> <p>D) Marked with a red slash</p>

2

4) Average scores per month and year can be viewed in the:

- A) Total Scoring chart
- B) Progress chart
- C) Help section
- D) Review Materials link

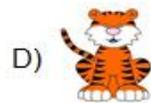
5) To review past assignments and study material click on the:

- A) Worksheets tab
- B) Scores tab
- C) Help tab
- D) Settings tab

6) The level of difficulty ranges from:

- A) 1 to 10, 10 being the most difficult
- B) 1 to 10, 1 being the most difficult
- C) 1 to 5, 5 being the most difficult
- D) 1 to 5, 1 being the most difficult

7) This character will guide you throughout the program:



8) The character's name is:

- A) Trixie
- B) Teddy
- C) Tyson
- D) Timmy

9) To print out material to work on, click on the:

- A) Games tab
- B) Worksheets tab
- C) Help tab
- D) My Activities tab

10) When you get an answer correct in a game, this will flash on the screen:

- A) Green check mark
- B) Red check mark
- C) Green star
- D) Red star

Thank you!



Appendix D: Educational Game Prototype Images

Math Mind

Level	Games	Worksheets	My Activities	Help
-------	-------	------------	---------------	------

Welcome to
Math Mind !

Login to begin...









Math Mind

Level	Games	Worksheets	My Activities	Help
-------	-------	------------	---------------	------

Login name

Password

[Create an account](#)

[Password Assistance](#)









Math Mind

Level
Games
Worksheets
My Activities
Help

Welcome back, **Jennifer!**

Your **Level 2** addition scores are excellent!

Why don't you review [Level 3](#) today and take your best shot at a game or worksheet.

Good Luck!



Log out






Math Mind

Level
Games
Worksheets
My Activities
Help

Level
1
2
3
4
5

Subject
Addition
Subtraction
Multiplication
Division



Log out






[Review Material](#)

Select a level and subject.

You have recently been working on **Level 3, Addition.**

Math Mind

Level
Games
Worksheets
My Activities
Help

Level
1
2
3
4
5

Subject
Addition
Subtraction
Multiplication
Division



Log out






[Review Material](#)

Math Mind

Level
Games
Worksheets
My Activities
Help

Level 3 - Addition

START

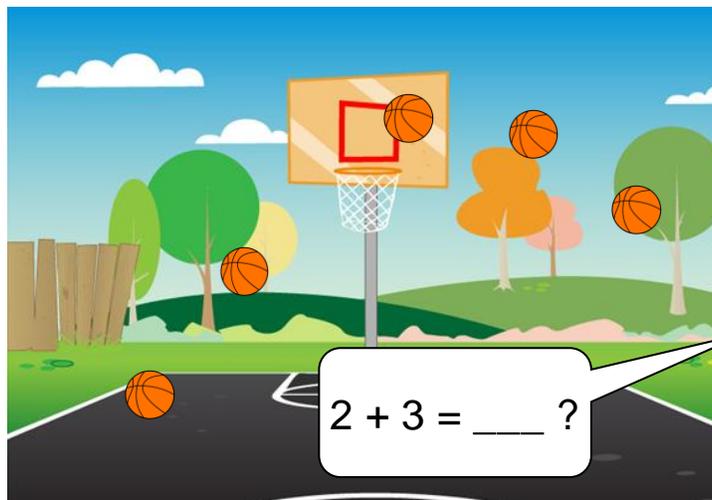


Log out

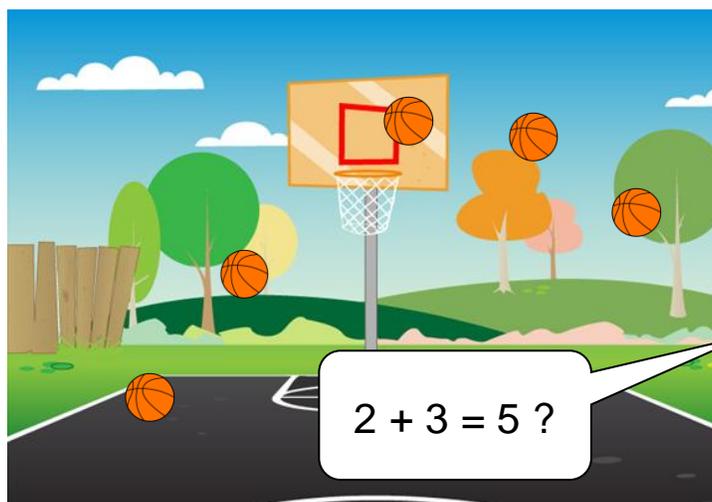




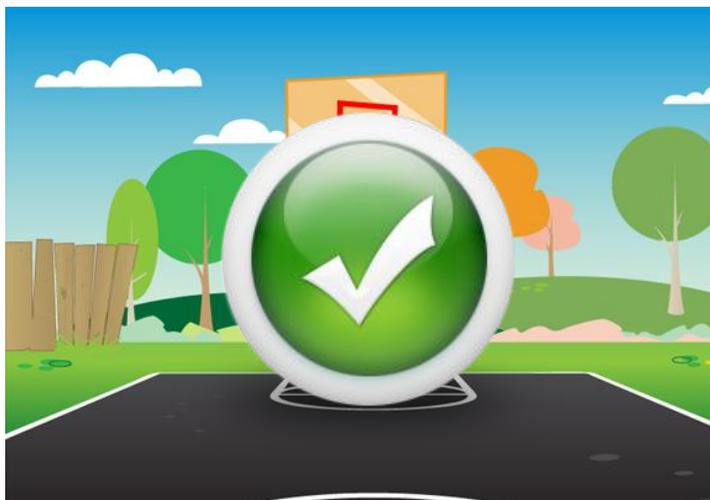

Math Mind

[Level](#)[Games](#)[Worksheets](#)[My Activities](#)[Help](#)[Log out](#)

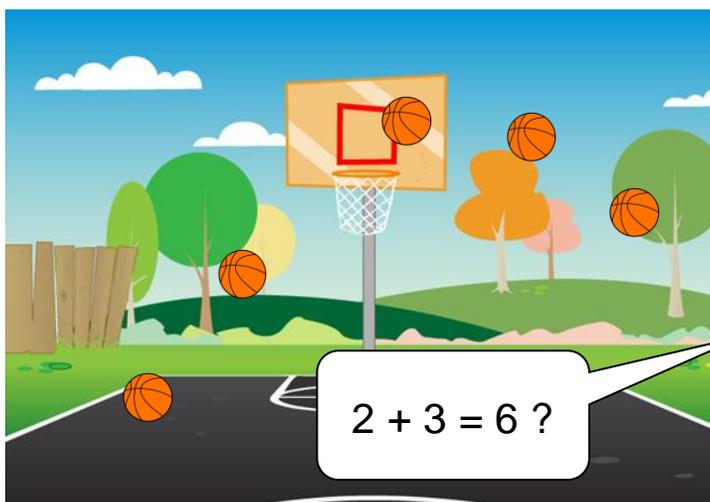
Math Mind

[Level](#)[Games](#)[Worksheets](#)[My Activities](#)[Help](#)[Log out](#)

Math Mind

[Level](#)[Games](#)[Worksheets](#)[My Activities](#)[Help](#)[Log out](#)

Math Mind

[Level](#)[Games](#)[Worksheets](#)[My Activities](#)[Help](#)[Log out](#)

$2 + 3 = 6 ?$

Math Mind

Level
Games
Worksheets
My Activities
Help





Log out









Math Mind

Level
Games
Help

Level 2 - Multiplication Score: 70%

✓ 1) $2 \times 3 = 6$	✓ 6) $7 \times 2 = 14$
✗ 2) $2 \times 5 = 15$	✗ 7) $9 \times 2 = 16$
✓ 3) $2 \times 1 = 2$	✓ 8) $10 \times 2 = 20$
✓ 4) $2 \times 4 = 8$	✗ 9) $11 \times 2 = 24$
✓ 5) $2 \times 8 = 16$	✓ 10) $6 \times 2 = 12$

[Click an answer to see the solution](#)

[Review Level 2 Multiplication](#)

Play Again

Main Menu



Log out









Math Mind

Level 2 - Multiplication Score: 70%

Level
Games
Worksheets
My Activities
Help

What is 2, 5 times? ✖

$2 \times 5 = 10$

Level
Games
Worksheets
My Activities
Help

Sheet 4

Sheet 5

Sheet 6

Sheet 7

Sheet 8

Sheet 9

[Log out](#)

Submit

Select a sheet. Click the printer button to print a worksheet or submit to record your answers.

Jennifer
Level 2 - Multiplication
Worksheet #12

1) $2 \times 3 = \underline{\quad}$ 6) $7 \times 2 = \underline{\quad}$
 2) $2 \times 5 = \underline{\quad}$ 7) $9 \times 2 = \underline{\quad}$
 3) $2 \times 1 = \underline{\quad}$ 8) $10 \times 2 = \underline{\quad}$
 4) $2 \times 4 = \underline{\quad}$ 9) $11 \times 2 = \underline{\quad}$
 5) $2 \times 8 = \underline{\quad}$ 10) $6 \times 2 = \underline{\quad}$

Submit Main Menu

My Activities Help

Log out




Jennifer Score: **90%**
Level 2 - Multiplication **Good job!**
Worksheet #12

1) $2 \times 3 = 6$ 6) $7 \times 2 = 14$
 2) $2 \times 5 = 10$ 7) $9 \times 2 = 18$
 3) $2 \times 1 = 2$ 8) $10 \times 2 = 20$
 4) $2 \times 4 = 8$ **✗** 9) $11 \times 2 = 24$
 5) $2 \times 8 = 16$ 10) $6 \times 2 = 12$

[Click an answer to see the solution](#)

[Review Level 2 Multiplication](#)

Worksheets Main Menu

My Activities Help

Log out




Math Mind

[Level](#)
[Games](#)
[Worksheets](#)
[My Activities](#)
[Help](#)


Michael's Grades

Total Scoring
Progress Chart
Addition
Subtraction
Multiplication
Division

[Log out](#)

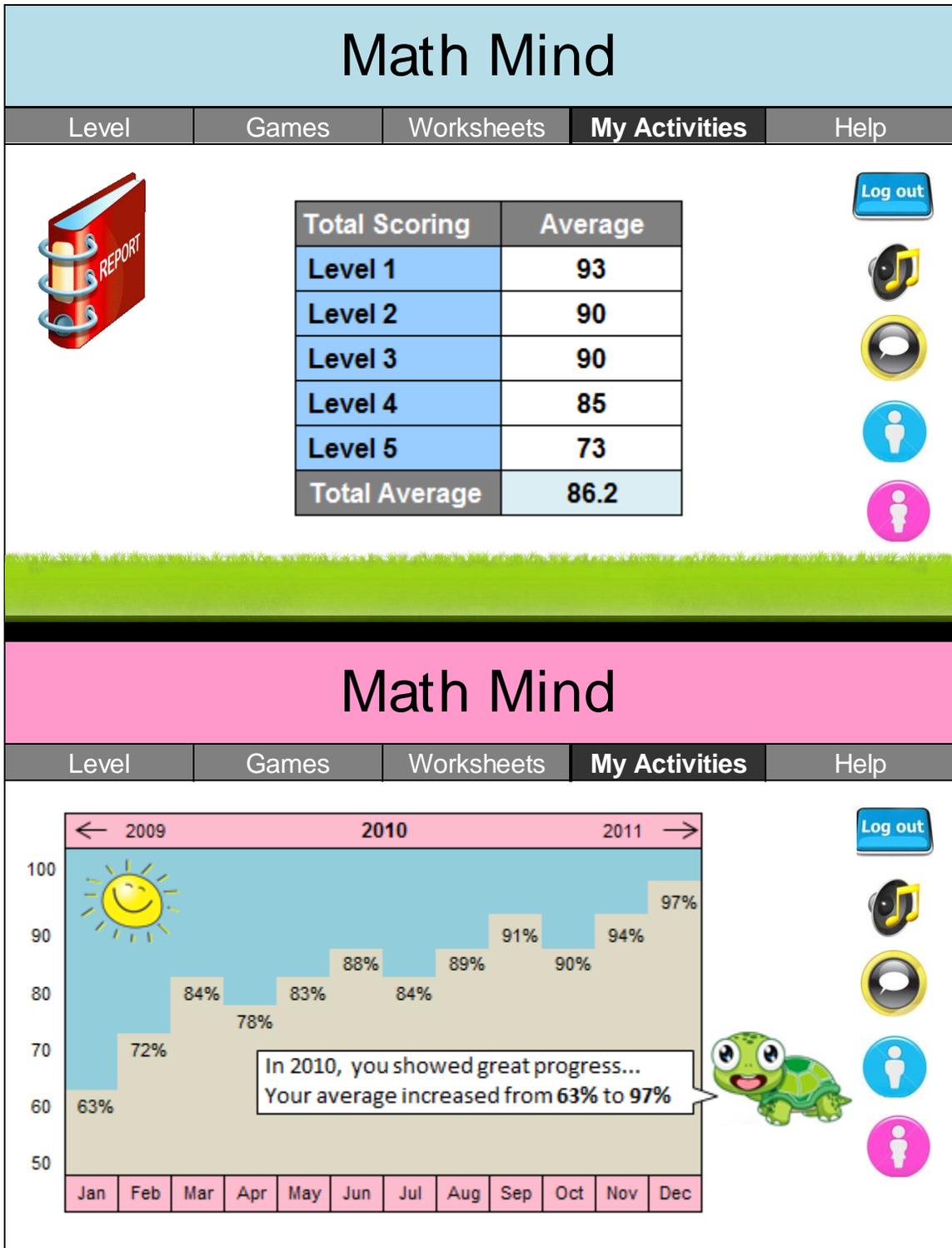

Math Mind

[Level](#)
[Games](#)
[Worksheets](#)
[My Activities](#)
[Help](#)


Michael's Grade Sheet

Subtraction	High Score	Average
Level 1	100	94
Level 2	100	91
Level 3	90	89
Level 4	80	75
Level 5	70	65
Total Average	82.8	

[Log out](#)

Math Mind

Level	Games	Worksheets	My Activities	Help
-------	-------	------------	---------------	------

[How to use Math Mind Tutorial](#)

[Review Material by Level](#)

[Review Past Assignments](#)

Search



Log out






Math Mind

Level	Games	Worksheets	My Activities	Help
-------	-------	------------	---------------	------

Learning how to use

Math Mind



Click the **Start** button above to begin

Log out






VITA

Christopher Roth was born in New York, NY in 1982. After attending St. Francis Preparatory, Christopher received a Bachelor of Science in Hospitality Management and minor in Business from St. John's University in January of 2004. He graduated magna cum laude, and received numerous awards for his work in Alpha Kappa Psi, the Professional Business Fraternity.

Christopher has worked as the Reservations Manager for a privately-owned hotel on Long Island and in the event planning and information technology fields.

