Investigating the Impact of Computers on the Motivation and Achievement of Fifth Graders

Jennifer Wagner
St. John Fisher College

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Investigating the Impact of Computers on the Motivation and Achievement of Fifth Graders

Performance on New York State Standardized tests are of importance to teachers across the country. This is especially true since the implementation of the No Child Left Behind Act of 2002 (US Department of Education, 2002). Under this legislation, test scores are to be available to the public. Therefore, in October of 2006, the New York State Department of Education released standardized test performance for Rochester, New York. One school in particular showed that approximately 18.2% of the current fifth graders performed acceptably on the state Mathematics exam in the 2005–2006 school year (NYSED 2006). Taking this data into consideration, it would seem obvious that increasing student performance in mathematics should be an important priority for teachers in that district.

Research into student performance spans all areas of learning. More recently, the incorporation of computers into the classroom has been a focus for many articles (Butzin, 2000; Nguyen, Hsieh, & Allen, 2006; Martindale, Pearson, Curda, & Pilcher, 2005; Maninger, 2006; Russell, Bebell, & Higgins, 2004; Swan, Hooft, Kratcostki, & Unger, 2005; Leonard, Davis, & Sidler, 2005; Steen, Brooks, & Lyon, 2006). What actually makes computers in the classroom work? Many theories exist, but trends in literature show there is a common thread; motivation on the part of the student to engage in activities that use computers and interactive software make computers an effective learning tool (Taylor & Adelman, 1999; Deal, 2004; Barak, 2004; Knight, Pennant, & Piggott, 2005).
With these factors in mind, the purpose of this research study is to show how the effective use of the interactive website *Project Interactivate* in Mathematical lesson planning at the 5th grade level will increase students' motivation to learn, therefore increasing student performance in Mathematics. Researchers will use a lesson study approach of reflection on lesson plan effectiveness. Lessons which incorporate interactive websites will be presented in a classroom of urban fifth grade students. Observations of time on task and competition of the activity will be noted and used during a reflection meeting between researchers after the lesson. The effectiveness of exactly what areas of the lesson were effective and how the lesson could become more effective in encouraging active learning will be discussed. The ideas and strategies discussed during reflection will then be used in subsequent lessons to increase the effectiveness of the lesson plans. The ultimate goal of these presentation, reflection, revisions, and presentation cycle is to benefit the students with increased student engagement and achievement in mathematics. Before the collection of data and presentation of lessons can continue, a thorough investigation of past research into motivation's effect on achievement, as well as the effects of computers on motivation and achievement will be discussed.
Literature Review

With the onset of No Child Left Behind (NCLB) legislation which was signed in January 2002, many teachers' minds are fixated with standardized test scores since they are used as a measure of the success of students across the country. NCLB sets high standards for schools to show adequate yearly progress (AYP) towards achievement for all students. According to President Bush "schools must have clear, measurable goals focused on basic skills and essential knowledge," (US Department of Education, 2002) in order to receive federal funding. Therefore, students in third through eighth grades are now tested every year in Mathematics and English, Language Arts. These tests are seen as a standardized measure of achievement which allows schools and districts to share progress with parents and the community. When success is shown through these standardized tests, these effective school programs and districts can continue to receive their federal funding. Schools which do not show adequate yearly progress for more than three years consecutively will be placed under state control. When this happens, parents also have a right to transfer their children out of non-performing schools into other schools in the immediate area which may be performing adequately. No school wishes to be labeled a non-performing school.

This pressure from the top has pushed teachers to look for creative and innovative strategies to improve student performance in Mathematics and English, Language Arts. Since motivation can often be a barrier to learning, addressing this issue is of importance (Adelman & Taylor, 1999; Aunola, Leskinen, & Nurmi, 2006; Stevens, Olivarez, Lan, & Tallent-Runnels, 2004; Caldwell & Ginther, 1996; Lutz, Guthrie, & Davis, 2006;
Simpkins, Kean, & Eccles, 2006). Teachers throughout time have always looked for ways to motivate those who were unmotivated. Over the years the traumatizing dunce cap and corporal punishment ideas of old are being replaced with theories into behavior modification, classroom management, and making learning fun and exciting. If the intrigue of computers, software and the internet were previously available to motivate students to learn, many knuckles might have been saved from the dreaded ruler.

Numerous research studies have sited that computer use in the classroom increases students' motivation to learn (Butzin, 2000; Caldwell & Ginther, 1996; Chaffin, Maxwell, & Thompson, 1982; Lutz, Guthrie, & Davis, 2006). It would only seem a logical step to incorporate computer use into the classroom instruction for the ultimate mission to increase student performance. If this is true, one would have to show a correlation between motivation and improved achievement.

**Motivation and Achievement**

Motivation can be described as a willingness, desire and need to participate and be successful and it plays a significant role in the success or failure in learning activities for all students (Deal, 2004). When students want to learn, they will learn, and they will learn more. This is shown to be true across racial boundaries, socio-economic status (SES), curriculum subjects and learning styles (Caldwell & Ginther, 1996; Stevens, et.al, 2004; DuPaul & Weyandt, 2006; Sideridis & Scanlon, 2006; Lutz, et. al., 2006). It has also been found that when teachers use motivation as a basis for pedagogical content, student achievement rises (Aunola, Leskinen, & Nurmi, 2006). Therefore, it can be said that motivation plays a significant role in the success or failure in learning activities for
all students (Deal, 2004; Sideridis, Scanlon, 2006). How can motivation have such an impact on the achievement of students?

Motivation is found to work best for achievement when it is personalized and specific for that individual and then encourages students to take an active role in their learning (Taylor & Adelman, 1999). When students are participants in their learning, acquisition of new knowledge, discovery and understanding, there is a sense of empowerment and ownership for their accomplishments. This new knowledge now belongs to the student, not borrowed from the teacher. This ownership of knowledge is the basis of the Constructivist method of teaching and already is well accepted and established in the educational field as an effective teaching philosophy (Confrey, 1990).

Caldwell and Ginther (1996) reported that all significant variables in the results of their study into the differences of learning styles of low socio-economic status learners were related to motivation. A key component of these results was a sense of control. Students who thought failure and/or poor performance were beyond their control felt no hope in improving their grades. The more controlling a teacher was over student behaviors the more negatively it affected performance. In this case, motivation actually predicted achievement rather than environmental factors, as was first thought. It was found that when low SES students were active participants in their own learning and teachers were less controlling, students showed enhanced motivation and held the idea that trying your best can be productive and valuable. High achievers in reading and mathematics were characterized as highly motivated, persistent and responsible.

This sense of control and empowerment supporting motivation was discussed in another study which involved an African-American algebra student. Corey and Bower
(2005) stated that the subject in this case study attributed his success in an Algebra course to the personalization, control of the pace of learning, and the on-line course's adaptation to his learning style. The teacher-controlled atmosphere was threatening to the subject. But when a web-based course was administered, the subject felt more in control of the learning and pace (of learning) and therefore performed better overall in the course.

Student motivation also increases performance of students with learning disabilities (LD). This was seen when student empowerment and peer tutoring strategies were used in a study from Sideridis and Scanlon (2006). Here the authors report that motivation and empowerment act as buffers that mediate the impact of stress from failure. One LD student with Attention-Deficit Hyperactivity Disorder (ADHD) improved performance in spelling to be the third in the school by incorporating a peer-tutoring program. At the conclusion of the trial, the student asked the principal when the peer-tutoring would reconvene because since that time, his grades had fallen. The intervention of the peer-tutoring program had increased his motivation and performance with a sense of empowerment and resilience to failure. Intervention that increased motivation positively effected the academic functioning of LD students (Sideridis & Scanlon, 2006).

The relationship between motivation and achievement has been explored across ethnicity as well as learning styles. Stevens, et.al. (2004) researched the effects of prior experiences in Mathematics achievement on the motivation of Hispanic students versus Caucasian students. It was discovered that students' beliefs and motivation played an important role in the achievement of students in Mathematics. Students who enjoyed math would work on a Mathematics task longer and often times when not required. This
increased time on task lead to greater achievement in Mathematics than those students who did not view mathematics as important and therefore did not put forth as much effort to succeed. The increased achievement was believed to be attributed to their willingness to participate rather than their self-image of ability, since it was found that prior achievement levels were directly related to the increased motivation.

Motivation plays a role in the success of students across disciplines as well. Students in fourth grade classrooms where engaging science content was incorporated within their reading instruction outperformed students in traditional classrooms (Lutz, et.al., 2006). Teachers received summer professional development on how to use the materials provided and effectively incorporate reading comprehension strategies into the Science content. The test classrooms received materials for science experiments, portfolios, lesson plans and fiction and non-fiction trade books. The control group utilized traditional teaching methods of basal readers and compartmentalized subject teaching. The results of the study showed that the test classes showed strong growth of the use of reading comprehension strategies and higher achievement levels than the traditional classroom. The authors attribute the higher achievement levels to the level of engagement of the students in the test classes.

When exploring the success of elementary students in Mathematics over time, motivation was a factor as well. Results from Aunola, et.al. (2006) showed that children’s mathematical performance and task motivation formed a cycle. A high level of math performance at the beginning of first grade increased the motivation of students towards Mathematics and performance in subsequent grades. This was found to be evident in the classrooms where teachers considered motivation to be an important
pedagogical goal. A total of 196 students from 17 classrooms and 13 different schools were used in this study of pre-school, first and second grade mathematics performance. Students were tested in mathematical performance and task motivation at four different time intervals. Results of the study showed high levels of math performance at the beginning of preschool increased subsequent motivation towards mathematics and later predicted math performance later on. At further investigation of the results of teacher interviews, students of teachers who mentioned motivation or self-concept as one of their most important goals showed a greater degree of change in their motivation towards mathematics' tasks.

Motivation appears to play a role in the success or failure for students. This has been evident across racial boundaries, learning styles, grade levels and subject disciplines. African-American and Hispanic students have been shown to not perform as well when they are not engaged in the learning process (Leonard & Davis, 2005; Stevens, et al., 2004). When learning styles as well as SES status are addressed, students still perform better when well motivated and empowered (Sideridis & Scanlon, 2006; Caldwell & Ginther, 1996). Motivation was key to increased performance even in a reading class (Lutz, et al., 2006) as well in early primary Mathematics instruction (Aunola, et al., 2006).

Motivation and Technology

It is understood, through a plethora of research, that motivation increases achievement across race, SES status, learning style and subjects. In order to make the connection between technology influencing achievements through motivational means,
how, then, is technology related to motivation? With the encroachment of technology on every aspect of our lives, children are growing up in a digital world unlike the one in which most adults understand. They are the fast-paced generation of video games, computers and the Internet. It only takes a few moments of watching a child sit and play video games to see a link between motivation and technology. Parents everywhere often complain of their children spending too much time playing video games and not enough time on homework and studying. Research does exist to support this common-sense belief, though (Habgood, Ainsworth, & Benford, 2005). When looking into this phenomenon, instant feedback was regarded as an effective and motivational feature of computers and video games (Chaffin, Maxwell, & Thompson, 1982). Therefore, video games are one an example of how the instant feedback offered through technology can motivate children. Students can know in a matter of seconds if their decision was correct or not and student can then change that decision through numerous trials in a limited amount of time. This level of feedback present in video games has been recommended for educational software (Steen, Brooks, & Lyon, 2006). Through the use of graphics, sound, color and interactive abilities, technology has the potential to engage and motivate low performing students, especially from urban areas (Guha & Leonard, 2002).

Overall, the majority of research regarding technology and motivation states that instant feedback, repetition of practice, efficient use of time, and teacher ingeneration were the driving forces of using technology to motivate learning (Martindale, et.al, 2005; Steen, Brooks, & Lyon, 2006; Knight, Pennant, & Piggott, 2005). Guha and Leonard (2002) found that students who used computer-assisted instruction enjoyed being able to work at their own pace and stated the positive comments and reward points as a reason
for motivation. Students who were found to be behind in math benefited from the tutorial programs that computer software have to offer. Some reasons for this was that students were able to work at their pace and build their confidence as they moved up through different levels of the program. These programs were able to offer immediate feedback regarding their answer by awarding points for correct answers and explaining incorrect answers and how to correct them later.

As well, the interactivity of computer technology was the basis to motivation in. research findings by Martindale, et.al. (2005) where online applications were studied for their impact on standardized test scores in Florida. Here the researchers used a test preparation software program designed specifically for the Florida Comprehensive Assessment Test (FCAT). The software was web-based and could be accessed from any internet connected computer; therefore, students could access the program from home as well as from school. The program used a variety of formats to present standards based content to students. Results found that the students whom used the software program most often out performed those students whom did not use the software and/or not to the same extent of the higher achieving students.

Several studies found that students attend to lessons better when technology was used. When using a projector and interactive software for presentations, students attended better to the large screen than televisions or any other media (Maninger, 2006). In that study, students had a 1:1 student to computer ratio and used interactive, hand-held devices that could input information directly into the teacher's computer. This interaction resulted in extremely high student motivation and behavior that indicated a commitment to learning. One teacher stated that "When I place technology in their
hands, behavior problems disappear” (p. 43). This was expressed regarding a class of students whom had previously failed the same course and who now were not exhibiting any behavior problems whatsoever. This same trend was seen in the results of research conducted by Russell, Bebell, and Higgins (2004). Here, there was an increase in student engagement, almost complete use of technology in writing, and a decrease occurrence of disciplinary problems in a classroom with a 1:1 technology to student ratio.

A study on the effects of interactive white boards in the classroom discovered the same results. There was a positive impact on motivation and engagement when white boards were used in the classroom (Knight, Pennant, & Piggott, 2005). The teachers in this study conducted an action research project focusing on a particular issue they felt would help them develop their skills of incorporating technology into their classrooms. The teachers attended workshops and held reflective discussions regarding their lessons and use of the whiteboard. By the end of the study, students were found to have raised self-esteem and benefited from the re-visiting of previous lessons using the software included with the white boards. The teachers agreed that the success of the project was due in part by the whiteboard and the software that comes packaged with that technology.

Students are motivated and engaged when they can express themselves through a variety of media (Aho, 2005). PowerPoint can be used to sequence and categorize their information, as well as present it systematically to peers. The use of graphics and other multi-media in their presentations connect to different modalities the learning. Using KidPix or inspiration allows the student more ways to organize their information and create concept maps of their conceptual understanding of Science content. Writing process skills are developed when students are required to use word processing programs.
The program alerts them to spelling and grammatical errors, yet the student still has to actively distinguish the correct form. Using the outline view of Microsoft Word also helps students to organize their writing in a logical sequence and order. Technology provides a creative way for students to respond to literature, science, and math (Watts-Taffe, et al. 2003).

Even at the first grade level computers have shown to catch and hold students' attention. The virtual manipulatives used in the Steen, Brooks and Lyon (2006) study kept students focused, increased the quantity and quality of practice that could not be achieved with pencil and paper activities. Students were either in a test group that used a computer generated manipulative of geometric shapes, or a control group that used pencil, paper and traditional manipulatives like pattern blocks and geo-boards. Students at this grade level were able to demonstrate their ability to transfer what they had learned on the computer to a pencil-paper test. Not only was the instant feedback of the virtual manipulative found motivating, but also the fact that the clean-up of materials was incredibly more efficient that the pattern blocks and rubber bands of the geo-boards.

Further research showed that students who used computer based learning practice found Mathematics more enjoyable (Nguyen, et al. 2006). The web-based practice tool used in this study of learning attitudes was reported to substantially help students build motivation and elevate the meaning of learning and doing mathematics. This was in part by allowing students a chance for practice, self-testing, self-regulation and self-evaluation. Teachers were also given more time and opportunities to interact and offer feedback to students. Since test scores and performance levels were automatically recorded and tracked by the software, teachers saved time in reading, grading and
administrative tasks of the classroom. Therefore, the web-based practice and assessment increased confidence, motivation and the interaction between the students themselves and between the students and the teacher. Many students reported that they enjoyed working with and preferred computer math practice. In fact, the self-efficacy of Hispanic students in this study rose in regards to their ability to complete Mathematics problems successfully. These assessments and practice programs improved students’ confidence in Mathematics problem solving, reduced their anxiety in test taking, and motivated them to learn mathematics (Nguyen, Hsieh, and Allen, 2006).

Computers have been shown to increase student motivation with their interactivity, multimedia dimensions and instant feedback mechanisms. When teachers incorporate technology’s interactive, hands-on lessons which offer immediate and constant feedback students are kept involved in learning longer. The tangible dimensions of technology may be a reason for the increased attention and motivation placed on learning when they are used (Deal, 2004). These experiences promote deeper learning and address higher order thinking skills (Barak, 2004). This appears to be evidence that technology positively effects motivation which leads to the link between technology and achievement.

*Technology and Achievement*

Educators across the globe continually search for better ways for students to acquire new knowledge and understanding. A long-time and well-studied technique is differentiation. The main ideas of differentiated instruction are that teachers should use pre-assessments to determine which instructional level the student learns best, tailor
instruction to each individual according to that instructional level and learning style while tapping into the student's personal interests to engage motivation. With the ever-advancing realms of technology, it would seem that this tool could offer teachers a plethora of options in which to differentiate the instruction in the classroom. The options are only bounded by the imagination and training of the educator. Technology can help the teacher in addressing these learning styles. Computers and technology accommodate a variety of learning styles. They support higher order thinking and teach problem solving skills (Martindale, et.al. 2005). Beyond the fact that numerous studies have shown computers to be effective means to increase student performance, there are trends with which to use technology in the classroom for this effectiveness to be apparent (DuPaul & Weyandt, 2006; Sideridis & Scanlon, 2006; Butzin, 2000; Leonard, Davis & Sidler, 2005; Russell, Bebell, & Higgins, 2004; Martindale, et.al. 2005; Maninger, 2006).

In order to see effective results, the computer instruction needs to support the learning taking place in the classroom, integrated with in the lessons (delivery and practice), be interactive and exciting, as well as accessible to as many of the students as possible.

Maninger's (2006) research in an English Literature class possessed all of these features and proved to be quite successful at raising test scores of at-risk students in ninth grade. Technology was used as a delivery tool for instruction where the teacher used a laptop computer connected to a LCD projector during lessons. Student could compare their work on individual laptops with what was projected on the large screen. As well, computer software supplied with the laptop allowed for students to interact with the computer using remote devices to input work and scores directly into the program. This allowed for a streamlined assessment process freeing up more time for instruction and
remediation rather than administrative tasks of the teacher. There was a 1:1 ratio of laptop computers to students and the teacher used the computers often. An intensive research project or webquest was planned every month on top of daily assignments such as written reports and blogs used to replace daily handwritten journals. At the conclusion of the study, 96% of the technology infused classroom students passed the state mandated standardized test as compared to 86% from the traditional instructional classroom.

An increase of test scores held true for the ten year study Project CHILD (Butzin, 2000). Before the project began, the elementary school studies was designated a critically low performing school with barely 10% of students achieving above the 50th percentile in Mathematics and Reading. After the study, there were more than 55% of student performing above those numbers.

Many of the same common threads of incorporation, practice and support of the classroom lessons hold true for this study as well. The materials used for Project CHILD allowed for interesting and stimulating lessons in Mathematics and Reading. Direct instruction was supported by skill practice and concept development at computer workstations with three to six computers. Allowing students to work at their own pace maximized time-on-task and student empowerment over the course of the study. Students were actively engaged in a variety of learning tasks that incorporated many learning styles as well as receiving continual and immediate feedback from software, peers and teachers. The Project CHILD students had better test scores in reading, language arts and mathematics than their counterparts in traditional classrooms. Not only were there a decrease in discipline problems, but students also exhibited better attitudes towards school and learning. Another encouraging outcome from this study was that the
students were found to continue to show positive effects over time since they kept their higher grade point averages and higher standardized test scores in consecutive years as well as more enrollment in advanced mathematics classes was reported.

Use of the Internet in the Science classroom for research is an obvious way to assist student performance. Students need to know how to scan for information, read headings and bold print to distinguish between important and irrelevant information and then synthesize that information into something meaningful. Using on-line encyclopedias exposes students the types of information contained within (Watts-Taffe, et al. 2003). If student work is created and filed electronically, offers an instant archive of authentic materials which can be used to hone metacognitive skills in students.

As mentioned earlier, students can create newsletters to communicate with parents regarding the events of the classroom (Watts-Taffe, et.al. 2003). As well, using the classroom website, students can publish their work and accomplishments to share with peers and the public. Technology offers a way for students to continue their learning and discussions outside of the classroom with e-mail communication and guided chat-rooms. Not only is peer collaboration important in literacy, but Science and Math curriculum uses collaboration in an ever increasing way.

Technology has not only helped to improve the performance of at-risk students, but students with disabilities have seen benefits. Computer mediated interventions with students with Attention Deficit Hyperactivity Disorder (ADHD) have shown to increase academic functioning (DuPaul & Weyandt, 2006). The computer assisted instruction allowed students to focus their attention on academic stimuli. Computers allow teachers and students to break the information into smaller bits, utilize multiple senses to obtain
drop features to engage students in interactive learning. The researchers discovered that using a culturally relevant theme for the software effected the motivation and performance of the students participating in the study. On average, there were 92% passing scores in Science and 74% passing score in Mathematics.

It would seem to hold true that technology use in the classroom improves student performance through its instructional adaptability and effects on the motivation of students. Classrooms across disciplines, ethnicity and learning abilities have shown increased achievement when technology is effectively incorporated into classroom instruction and practice. Use of computers in the classroom has lead to an increase in engagement, a decrease in student discipline problems and an increase in standardized test scores (Russell, Bebell, & Higgins, 2004). It is the goal of this current research to duplicate these results by designing and implementing effective lessons which incorporate interactive websites with low performing 5th grade students in order to increase motivation and performance in Mathematics.
Methodology

This research used Lesson Study to observe the motivational impact of computer use on the performance of elementary aged children. As part of usual classroom activities, this research was expected to improve the effectiveness of lessons by incorporating computers into classroom instruction for the benefit of student performance. Lessons that involved interactive computer programs and websites were incorporated into the regular curriculum. The researchers then used the lesson study model to observe the effectiveness of the lesson. Lesson study model involves collaboration and observations among teachers to improve classroom learning.

Participants and Setting

Nineteen fifth and sixth grade students from an inner city classrooms participated in this study. Gender demographics were thirteen girls and six boys, 95% African American decent and 5% Caucasian. All students are presently registered to the researcher’s fifth grade classroom. From the total population of participants, fourteen students were general education students, two students had a 504 plan written, and three students had an Individualized Educational Plan (IEP) on file.

Entering the classroom, observers would notice the room had a student friendly configuration which included many areas with an obvious purpose. There were areas for small and large group lessons, comfortable reading and multimedia access, teacher work center, and classroom library. Posters and charts were prominently displayed for student access, as well as student work posted.
The computer lab contained twenty-five, internet connected desktop computers. The computers were arranged in a semi-circle facing the outside walls of the classroom allowing the teacher to view the monitor screens from any point in the room. All chairs had tennis-balls attached to the bottoms of each leg to reduce noise during movement.

Materials

The teacher work center was equipped with a desktop computer which utilized the internet and a LCD projector for demonstrations. During the observed lessons in the regular classroom, students accessed the internet using wireless Dell laptop computers which were part of a mobile laptop cart. This created a 2:1 student to computer ratio. During observed lessons in the computer lab students accessed the internet using Dell desktop computers at a 1:1 ratio. The interactive website Project Interactivate sponsored by SHODOR Education Foundation, Incorporated was used for all web-based activities. Students printed their work on the laser printer supplied with the wireless laptop cart. No printer was used in the computer lab. Students were provided with an activity created by researchers to record their results of the activity.

A journal using lesson study observation protocol (Appendix G) of observed time on task of the class as whole and qualitative observations was used as a gauge of motivation. Student performance was measured before and after the research period by using the RCSD foundational and mid-year (Appendix E) mathematics examination questions relating to the research content. A short timed multiplication facts quiz (Appendix F) was also used before and after research for multiplication fluency achievement. The researchers were the only people with access to the data. It was stored in a locked file cabinet and destroyed after the completion of the project. Since
performance and motivation of the class as a whole were considered, no individual
students were identified in the study.

Procedure

Student needs in Mathematics were identified using a foundational assessment
and mid-year assessment administered by the city school district. These needs were used
to identify skills and concepts to address for interactive web-based lessons which were
written collaboratively between the researchers. These lessons were observed,
collaboratively reflected upon and revised using the lesson study approach.

The main skill or concept that needed to be taught was introduced to the students
in a mini-lesson format to engage their thinking. Students then used the computer to
explore the concept in more depth with the use of the interactive website. A rubric was
used to evaluate student understanding based on students’ written explanation of their
experience and process using the web-based activity.

At first the class was divided in two groups. A technology paraprofessional
conducted separate, unrelated activities with half the class while the research teacher
administered the interactive mathematics lessons with the other students. Later it was
decided that a whole group setting would be more conducive to the learning environment.

A research observer took notes and made observations during the lesson. The
focus of observations was to notice on-task behavior as a measure of motivation. A
journal of observed time on task of the class as a whole will be used as a gauge of
motivation. The general effectiveness of the lesson was also noted during these
observations which included lesson fluency and student content understanding.
These observations, which focused on motivation, on-task behavior and lesson effectiveness, and rubric scores, were the basis for discussion during collaborative reflections. Lesson effectiveness was discussed and areas of the lesson and activity that needed attention were revised. The revised lesson was then taught to the half of the class that did not participate in the first lesson. When the change to whole group lessons occurred, the lesson was re-taught to the whole group a second time to address the alterations. Observations focused on motivation, on-task behavior and effectiveness were again noted and used for subsequent revisions and collaboration. This process continued and repeated using other lessons and content for six weeks.
Results

Student performance was measured before and after the research period by using the RCSD foundational and mid-year mathematics examination questions relating to the research content (Appendix E). A short timed multiplication facts quiz was also used before and after research for multiplication fluency achievement. A journal of observed time on task of the class as whole and qualitative observations was used as a gauge of motivation.

Quantitative Results

Overall performance on the RCSD foundational exam increased from 38.1% pre-test passing (Table 1) to 59.52% passing on the post-test (Table 2). Performance on exam questions relating to multiplication increased from 38.33% passing to 59.17% passing post-test. Geometry exam questions rose from 25% passing pre-test to 66.67% passing post-test. As well, questions relating to fractions rose from 50% competency to 54.17% competency post-test.

Results from the mid-year RCSD exam also increased from an overall score of 26.39% competency pre-test (Table 3) to 55.36% competency post-test (Table 4). Individual questions relating to multiplication increased from 9.38% correct pre-test to 21.43% correct. Questions pertaining to geometry increased from 78.13% to 89.29% correct post-test. Exam questions relating to fractions increased from 23.75% correct to 50.71% correct post-test. As well, questions pertaining to coordinate pairs increased from 31.25% correct pre-test to 78.57% correct post-test.
### Table 1

Rochester City School District Foundational Assessment

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<th>Q12-m</th>
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| percent | 58.33 | 8.33 | 41.67 | 41.67 | 41.67 | 25.00 | 50.00 |

| multiplication average | 38.33 |
| geo average | 25 |
| fraction average | 50 |

| Overall Average | 38.10 |
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Post-Foundational Assessment

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Table 4

Post- Mid-year Assessment

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| totals        | 6      | 25     | 12     | 18     | 16     | 15     | 10     | 22     |
| full credit   | 28     | 28     | 28     | 28     | 28     | 28     | 28     | 28     |
| percent       | 21.43  | 89.29  | 42.86  | 64.29  | 57.14  | 53.57  | 35.71  | 78.57  |
| fraction average | 50.71  |
| geometry average | 89.29  |
| coordinates average | 78.57  |
| multiplication average | 21.43  |
| Overall Average | 55.35714 |
Performance on the multiplication fluency timed test increased from 69.61% of problems completed pre-test to 80.89% completion post-test (Table 5). Accuracy of the completed questions rose from 94.89% correct to 97.11% correct post-test.

Qualitative Results

A journal of observed time on task of the class as whole and qualitative observations was used as a gauge of motivation. Observations were recorded at each round of lesson study trials in each content area using the lesson study observation protocol (Appendix G). Overall motivation and on-task behavior increased after each round of adjustments made to the lesson. Students started the sessions being talkative, distracted and needing much support from teachers. In a whole group lesson, this behavior was noted more often than when computers were present. As sessions continued and technology troubles diminished, students became engaged, excited and even sparked friendly competition among each other. By the end of the study, students were collaborating and cooperating, offering assistance and encouragement to others on a regular basis. Start-up time decreased significantly, no only due to less technology problems, but a familiarity of the website, games and login process in general.

Geometry Lesson

The geometry activity's objective was that students will be able to compare and contrast four shapes, colors, and sizes using an interactive Venn diagram (Appendix A). Students were mostly engaged during the first round of the lesson. Peer encouragement was also noted. There were problems with technology in that loading time was extended,
### Table 5

Multiplication Fluency Assessment

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the website was not readily accessible and some computers restarted which lead to the off-task behavior that was observed. It was noted that the lesson needed to be differentiated for some students based on their readiness. This was taken into consideration for the second round of the lesson.

For the second round of the geometry lesson a few alterations were made to the lesson. A mini-lesson presented by the teacher to the students regarding how to use a Venn diagram. The teacher demonstrated one example of how to complete the activity with the class to clarify confusions seen during the first round of the lesson. Access to the website was more readily available by posting a link on the classroom webpage. Students were required to explain in a sentence how they completed the activity.

The second round of the geometry lesson resulted in some of the same trends as the first round in that students were distracted and off-task when computers were not present. Once computers were introduced, students were on-task, engaged and fully interested in the activity at hand. Much peer collaboration and cooperation was observed, as well as some friendly competition and peer encouragement. Numerous and multiple successes were noted as some students completed the activity several times in the allotted time frame.

Coordinate Pairs Lesson

The coordinate pairs objectives were that students will plot points on a grid to navigate around obstacles and write the coordinates of each plotted point as a coordinate pair (Appendix B). A mini-lesson demonstrating how to complete the activity was presented by the teacher before the activity was initiated. When students were in the presence of the computers, they were all on task and fully engaged. Student cooperation
and peer discussion about the activity were observed. There was peer assistance and encouragement noted as well as friendly competitions with numerous and multiple successes.

Observations during the activity noted that many students were not documenting their progress. Therefore, the worksheet provided was altered to make it more child-friendly and the students were reminded throughout the second round of the lesson to write down their progress. It was also noted that some pairs of students were having greater difficulty with the content of the activity than others. Therefore, the activity was differentiated for those specific pairs of students during the second round allowing them to use only one quadrant of coordinates instead of four.

Students were mostly off-task during the mini-lesson as well as during the ten minute wait for the technology to be working properly. Once the computers and website activity were in progress all students were on-task with full engagement. There were numerous peer discussions regarding the activity. Student cooperation and peer assistance was observed as well as friendly competition and encouragement. There were numerous and multiple successes in the allotted time frame. The students continued to discuss the interactive computer game after the activity was completed.

Multiplication Fluency Lesson

The multiplication fluency lesson objectives were that students will complete timed multiplication problems and complete at least four interactive games with a partner (Appendix C). Students were mostly off-task during the mini-lesson conducted by the teacher to explain the process of the interactive game. When the activity was in session, students encountered problems with pop-up windows and scoreboard re-setting. Students
did not consistently record their scores on the worksheet provided by the teacher. It was observed that students were mostly engaged and having fun during the activity. There was much peer encouragement and cooperation as well as some friendly competition among groups.

As the activity progressed, it was observed that some student pairs needed the lesson to be differentiated due to their readiness. Therefore, the time limit was extended for those students for future rounds of this activity. Two groups needed the difficulty level to be extended since their achievement exceeded the expectations of the lesson. The time limit for these groups was extended due to the extensive nature of the multiplication problems at higher difficulty levels. The website activity itself was altered during the study, therefore, the worksheet needed to be changed to match the wording used on the website.

In subsequent rounds of this lesson there was much less technology problems than in the first round of the study. The computer lab was used exclusively to alleviate the technology problems. Students were observed to be loud and talkative, but engaged in the lesson and talking about the activity. Peer encouragement and cooperation was evident in all subsequent rounds of this lesson. Students were engaged in friendly competition among the groups. Differentiating the lesson for readiness showed more engagement by those student groups and allowed them to have fun and laugh with the other student groups without exposing the change in the activity.

Equivalent Fraction Lesson

The student objectives for the equivalent fraction lesson were that students would find equivalent fractions using an interactive computer activity and complete at least
eight games successfully (Appendix D). Due to unexpected school closings caused by weather and cold temperatures and a field trip for some, not all of the students completed all rounds of the fraction activity. The results of the fraction lesson study are included since the progress of the class as a whole, not individual students, was considered for this research. Since the students had completed several different activities using the same website and are familiar with its overall use, the teacher conducted a brief demonstration for this particular activity. When in the presence of the computers, students were fully engaged and interested in the interactive activity. Many students looked for reassurance from the teacher that they were correctly completing the activity.

Some students needed redirection to stay within the parameters of the lesson. Therefore, in the second round of the lesson students were specifically asked to use the square shape for the fraction model. Students that showed competency with the square model were allowed to move on to the more difficult circle shape offered by the site. Many student completions were observed, although only two students were able to complete eight examples in the allotted time frame. Most of the students who could not complete the expected eight completions were those that were not present during the first round. Many of the students whom experienced the activity prior were observed helping and tutoring their peers.
Discussion and Conclusion

This research study was successful in its goal to show that the use of computers in the classroom has led to an increase in engagement and standardized test scores by designing and implementing effective lessons which incorporate interactive websites with low performing 5th grade students. When students want to learn, they will learn, and will learn more. This is evident when students become participants in learning, the learning is tailored to the student, and they have a sense of control and empowerment over their education (Deal, 2004).

The students in this study were observed to be excited about activity at hand and engaged in the games. This is evident from their talkativeness and enthusiasm shown during observed lessons. Similar to previous cited studies, Mathematics became more enjoyable when technology was accessed (Nguyen, et al. 2006). Students were often laughing, joking and competing with each other for high scores. On quite a few instances, they students would not stop playing the games to move on the next subject. After some time, for many of the students, the grade they would be receiving became irrelevant; they were interested in playing the game and learning the content.

Students were seen to help out a neighbor and guide peers towards the correct responses, completely forgetting to record their own work for credit. Some worksheets were turned in with only a name printed at the top, when it was clearly observed that the student was participating and completing the assigned activity. This observation led the researchers to evaluate their directions and worksheets to make sure they were as clear and as simple as possible. In subsequent sessions, many oral reminders were made to
students that were seen not documenting their progress. As sessions continued, the students became better remembering to record their progress.

Another pattern observed that was addressed by the researchers was the lack of attention and engagement during mini-lessons. As the study progressed, the lecture time with the teacher decreased significantly. Students were becoming more familiar with the manipulation of the interactive games as well as conducting multiple sessions of the same lesson. It was soon discovered that the students needed less and less whole group direction and just a few reminders and clarification about the game. After only a few mini-lessons, students became self-sufficient with the activities and only needed the worksheet as a record of their success. Therefore, the lack of attention and engagement during lectures was eliminated since lectures were no longer needed.

Much of the success of technology on the motivation of the students was that the interactive websites offered instant feedback on responses, allowed for students to work at their own pace at their own level, and offered repetition of skills. This mirrors the results of Guha and Leonard (2002) that found that students who used computer-assisted instruction enjoyed being able to work at their own pace and stated the positive comments and reward points as a reason for motivation. For the current study, each correct response to a problem was given instant positive feedback and a score. Incorrect answers were responded to with encouragement and offered the correct answer. All answers were recorded by an automated scoreboard for the student. Since the student received their grades immediately and did not have to wait for a teacher to correct their responses. This allowed for faster corrections of misconceptions and acquisition of correct content in a shorter time period.
The researchers capitalized on this automated feature and changed worksheets so that the students needed to record this data manually, making the student more aware of their progress as they proceeded through the activity. Students knew in a matter of seconds if their decision was correct or not and could then change that decision through numerous trials in a limited amount of time. This allowed students a chance for practice, self-testing, self-regulation and self-evaluation which has been seen in research to be effective in raising performance (Nguyen, et.al. 2006). This was where the competition among peers emerged. Students began trying to outscore each other on certain activities. They would challenge others to beat their score and would get excited when they matched scores with higher achieving peers.

The repetitiveness aspect of technology has been sited in numerous research as a success factor in increasing student achievement (Martindale, et.al. 2005; Steen, Brooks, & Lyon, 2006; Knight, Pennant, & Piggott, 2005). The students of this study did improve, not only from problem to problem, but from lesson to lesson, as they progressed through activities. When students were given numerous sessions with the same activity, those trials improved achievement further. The multiplication game was used multiple times. By the last session, students were faster in their response time and completed more games during the allotted time than the previous session. This was due in part by the repetition allowed by the game and some of the fluency was a result of a familiarity with the activities themselves. When students were allowed to repeat the activities, each session was better than the previous. As a class, scores on all post-tests increased after the completion of the study.
A long-time and well-studied technique to increasing achievement and motivation is
differentiation which tailors instruction to each individual according to that instructional
level and learning style. Each interactive game that was used for this study allowed for
differentiation. There were settings for difficulty levels, timed response, color, shape,
and more. At the first session of using the interactive games in the classroom,
differentiation was needed. During the geometry Venn-diagram game, a few students did
not understand how to use the Venn-diagram at all, while others were ready to proceed.
Since each student had access to individual computers, the students that were ready to
move on were able to proceed without having to wait for students not at that level. In
turn, students that needed more assistance were allowed it since the advanced students
were occupied and engaged in their activity.

Later in the study, the differentiating aspects of the website were used during the
multiplication game. The students of the study were at all different levels of fluency for
multiplication facts. Some students could multiply automatically while others were
counting on fingers. The website allowed for different time intervals for responses, as
well as difficulty levels. Students who had advanced in their fluency were encouraged to
move on the more difficult levels while students who were still counting on fingers were
offered more time to respond to the question. At the end of the sessions, all students had
increased their fluency of multiplication problems.

Overall, the researchers found that to be effective, lessons needed to be relative to
the current instruction in the classroom or to a needed basic skill deficiency. The
worksheets for student responses needed to be simple with clear instructions that related
to the stimuli of the game. Effectiveness of the website was determinate upon its
interactivity, instant feedback capabilities and ability to differentiate and tailor to the individual student. In order to evaluate achievement, the game needed to collect data in some fashion, whether with percentage of correct responses or a scoreboard. This allowed for instant feedback to the students and alleviated the task of grading off the teacher so as to be more accessible to the students for questions and support.

Some considerations for future research can be made to investigate the impact of other websites on the achievement of students in Mathematics, perhaps using the interactive website called Muliflier which takes students on a trip through the solar system as they complete mathematics facts in a timed test. As well, the use of interactive websites can be explored in other subjects. Interactive models can be used in Science studies and the use of narrative, blogs, and interactive primary documents in Social Studies could be a route for future study. There exists many websites that offer interactive books that read to the student and phonics games that can be addressed to increase reading readiness and comprehension in English language Arts programs.

The students of today have been immersed in technology since birth and the impacts it has on our lives is never-ending. From fetal monitors to cell phones, to the miniature flash drive in which this research was stored, technology affects every aspect of our lives. It only seems natural to investigate how technology can positively effect the achievement of our students. Moore's Law states that our capacities in technology will double every eighteen months (Kaku, 1999). With this unbelievable idea in mind, the research that can proceed this investigation is unknown and never-ending since the roads in which technology can take us are unimaginable.
References


Appendix A

Geometry: Comparing and Contrasting Shapes and Sizes

Objective:
Students will be able to compare and contrast four shapes (square, triangle, circle and hexagon), colors and sizes using an interactive Venn diagram.

NYS Standards:
Students will recognize and use connections among Mathematical ideas
5.CN.2 – Explore and explain the relationship between Mathematical ideas.
Students will understand how Mathematical ideas interconnect and build on one another to produce a coherent whole.
5.CN.4 – Understand multiple representations and how they are related.
5.CN.5 – Model situations with objects and representations
Students will create and use representations to organize, record, and communicate Mathematical ideas.
5.R.1 – Use physical objects, drawing, charts, graphs, etc. created using technology as representations.

Mini-lesson:
Using chart paper, review the aspects of a square, triangle, circle and hexagon.
Using chart paper, review how to compare and contrast using a Venn diagram.

Activity:
Using a LCD projector, teacher demonstrates how to access the interactive website using a link from the classroom webpage. Teacher will then complete one example with the class. Teacher will then ask students to complete one example together
in order to ensure students can adequately maneuver the website. Then students are asked to successfully complete two “Guess the Rule” activities.

Assessment:

Successfully complete two “Guess the Rule” double Venn-Diagram activities on the SHodor Interactivate website. (http://www.shodor.org/interactivate/activities/ShapeSorter/) Print out the two completed pages of your successful trials and turn into the teacher. Briefly explain how your rule worked with a sentence or two on your print out.
Appendix B

Maze Game: Plotting Points on Cartesian Coordinates

Objectives:

• Students will plot points on the graph to navigate around obstacles.
• Students will write the coordinates of each point plotted.

NYS Standards:

Students will communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

5.CM.4 Share organized mathematical ideas through the manipulation of objects, numerical tables, drawings, pictures, charts, graphs, tables, diagrams, models, and symbols in written and verbal form.

Students will create and use representations to organize, record, and communicate mathematical ideas.

5.R.1 Use physical objects, drawings, charts, tables, graphs, symbols, equations, or objects created using technology as representations.

Students will apply coordinate geometry to analyze problem solving situations.

5.G.12 Identify and plot points in the first quadrant.

Mini-lesson:

Using chart paper, review Cartesian coordinates and plotting points on a grid.

Activity:

Teacher will complete one example of the “Maze Game” with the class. Then students will be asked to successfully complete at least two games recording the number of mines (which will increase with each game), start and finish points and all the points on their path using the provided sheet.

Assessment:

Successfully complete the provided sheet using the “Maze Game” activity on the SHODOR Interactivate website (http://www.shodor.org/interactivate/activities/MazeGame/). Students will complete at least two games in the allotted time and increase the number of mines for each game that they complete in order to be successful.
# Maze Game

Activity 1 Try to lead the robot to the green dot in as few steps as you can without going through a mine. Record your starting point, path and finishing point in the graph below.

<table>
<thead>
<tr>
<th>#</th>
<th>Start</th>
<th>Maze Coordinates</th>
<th>Finish</th>
<th># of mines</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>X Y</td>
<td></td>
<td>X Y</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>X Y</td>
<td></td>
<td>X Y</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>X Y</td>
<td></td>
<td>X Y</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>X Y</td>
<td></td>
<td>X Y</td>
<td></td>
</tr>
</tbody>
</table>

- **Accurately completed four complete mazes with at least one having more than 20 mines.**
- **Accurately completed three complete mazes with at least one having more than 20 mines.**
- **Accurately completed two complete mazes with at least one having more than 15 mines.**
- **Completed less than two mazes or no mazes with more than 15 mines.**
Appendix B

NAME: ___________________________ Date: ____________

Maze Game

Lead the robot to the green dot in as few steps as you can without going through a mine. Record your starting point, path, finishing point, and number of mines in the chart below.

<table>
<thead>
<tr>
<th>#</th>
<th>Start</th>
<th>Maze Coordinates</th>
<th>Finish</th>
<th># of mines</th>
</tr>
</thead>
<tbody>
<tr>
<td>EX.</td>
<td>(-10, -10)</td>
<td>(-5, -2) (-5, 5) (3, 5)</td>
<td>(10, 10)</td>
<td>5</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accurately completed three or more complete mazes with at least one having 15 or more mines.</td>
<td>Accurately completed two or more complete mazes with at least one having 10 or more mines.</td>
<td>Accurately completed one or more complete mazes with at least one having 5 or more mines.</td>
<td>Completed one or less mazes with 5 mines.</td>
</tr>
</tbody>
</table>
Appendix C

Arithmetic Four

Objectives:

- Students will complete multiplication problems.
- Students will complete at least four “Arithmetic Four” games with a partner.
- Students will keep track of their score and number of wins on the provided chart.

NYS Standards:

Students will create and use representations to organize, record, and communicate mathematical ideas.

- 5.R.1 Use physical objects, drawings, charts, tables, graphs, symbols, equations, or objects created using technology as representations.

Students will understand meanings of operations and procedures, and how they relate to one another.

- 3.N.20 Use a variety of strategies to solve multiplication problems with factors up to 12 x 12.
- 4.N.15 Select appropriate computational and operational methods to solve problems.
- 4.N.16 Understand various meanings of multiplication and division.
- 4.N.18 Use a variety of strategies to multiply two-digit numbers by one-digit numbers (with and without regrouping).

NCTM Standards:

- Compute fluently and make reasonable estimates.
- Develop, analyze, and explain methods for solving problems involving proportions, such as scaling and finding equivalent ratios.

Understand meanings of operations and how they relate to one another.

- Understand the meaning and effects of arithmetic operations with fractions, decimals, and integers.

Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

- Develop meaning for integers and represent and compare quantities with them.

Activity:

The teacher will complete one example of the “Arithmetic Four” game with the class (http://www.shodor.org/interactivate/activities/ArithmeticFour/). Then the students will be asked to successfully complete at least four games, keeping score on the chart provided.

Assessment:

Successfully complete two “Arithmetic Four” games with 100% accuracy in computation at the easy level and at least 85% accuracy in computation at the medium level.
### Arithmetic Four

The game works just like Connect Four: try to get four of your game pieces in a row. In order to earn a piece, you must complete a multiplication problem within the set time limit. Complete at least three games at easy and one game at medium difficulty level.

<table>
<thead>
<tr>
<th>Game</th>
<th>Player One</th>
<th>_____ out of _____</th>
<th>_____%</th>
<th>Did you win?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Player Two</td>
<td>_____ out of _____</td>
<td>_____%</td>
<td>Y or N</td>
</tr>
</tbody>
</table>

#### Game 1

<table>
<thead>
<tr>
<th>Game</th>
<th>Player One</th>
<th>_____ out of _____</th>
<th>_____%</th>
<th>Did you win?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 2</td>
<td>Player Two</td>
<td>_____ out of _____</td>
<td>_____%</td>
<td>Y or N</td>
</tr>
</tbody>
</table>

#### Game 3

<table>
<thead>
<tr>
<th>Game</th>
<th>Player One</th>
<th>_____ out of _____</th>
<th>_____%</th>
<th>Did you win?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Game 4</td>
<td>Player Two</td>
<td>_____ out of _____</td>
<td>_____%</td>
<td>Y or N</td>
</tr>
</tbody>
</table>

#### Game 5

<table>
<thead>
<tr>
<th>Game</th>
<th>Player One</th>
<th>_____ out of _____</th>
<th>_____%</th>
<th>Did you win?</th>
</tr>
</thead>
</table>

#### Results

<table>
<thead>
<tr>
<th></th>
<th>Completed four games or more with at least 85% accuracy on medium level and/or 100% accuracy on easy level</th>
<th>Completed three games with at least 85% accuracy on medium level and/or 100% accuracy on easy level or four games with less than 85% / 100%</th>
<th>Completed two games with at least 85% accuracy on medium level and/or 100% accuracy on easy level or 3-4 games with less than 85% / 100%</th>
<th>Completed less than three games with at least 85% accuracy on medium level and/or 100% accuracy on easy level or 2-4 games with less than 85% / 100%</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Arithmetic Four

The game works just like Connect Four. The object is to get four of your game pieces in any row, column or diagonal. In order to earn a piece, you must complete a multiplication problem within the set time limit. Before starting the game click “show score” to help you fill in the chart below. Do not forget to fill in your **difficulty level**.

***Try to complete ONE game at the medium level.***

---

<table>
<thead>
<tr>
<th>Game 1</th>
<th>Difficulty Level:</th>
<th>Black Player</th>
<th>Red Player</th>
<th>Did you win?</th>
<th>Y or N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>_ _ out of ____</td>
<td>_ _ out of ____</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>____ %</td>
<td>____ %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Game 2</th>
<th>Difficulty Level:</th>
<th>Black Player</th>
<th>Red Player</th>
<th>Did you win?</th>
<th>Y or N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>_ _ out of ____</td>
<td>_ _ out of ____</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>____ %</td>
<td>____ %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Game 3</th>
<th>Difficulty Level:</th>
<th>Black Player</th>
<th>Red Player</th>
<th>Did you win?</th>
<th>Y or N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>_ _ out of ____</td>
<td>_ _ out of ____</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>____ %</td>
<td>____ %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Game 4</th>
<th>Difficulty Level:</th>
<th>Black Player</th>
<th>Red Player</th>
<th>Did you win?</th>
<th>Y or N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>_ _ out of ____</td>
<td>_ _ out of ____</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>____ %</td>
<td>____ %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Game 5</th>
<th>Difficulty Level:</th>
<th>Black Player</th>
<th>Red Player</th>
<th>Did you win?</th>
<th>Y or N</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>_ _ out of ____</td>
<td>_ _ out of ____</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>____ %</td>
<td>____ %</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

<table>
<thead>
<tr>
<th>Completed four games</th>
<th>Completed three games</th>
<th>Completed two games</th>
<th>Completed one game</th>
</tr>
</thead>
<tbody>
<tr>
<td>or more with at least 85% accuracy on level one and/or one on level two</td>
<td>or more with at least 85% accuracy on level one whether not one was completed on level two</td>
<td>with at least 85% accuracy or more than two with less than 85% accuracy at the level one</td>
<td>with at least 85% accuracy or more than one with less than 85% accuracy at the level one</td>
</tr>
</tbody>
</table>
Appendix D

Equivalent Fraction Finder

Objectives:

• Students will find equivalent fractions.
• Students will complete at least eight of ten equivalent fraction problems.
• Students will keep track of their score and equivalent fractions.

NYS Standards:

Students will understand how mathematical ideas interconnect and build on one another to produce a coherent whole.

5.CN.4 Understand multiple representations and how they are related.

Students will create and use representations to organize, record, and communicate mathematical ideas.

5.R.1 Use physical objects, drawings, charts, tables, graphs, symbols, equations, or objects created using technology as representations.

5.R.3 Read, interpret, and extend external models.

5.R.4 Use standard and nonstandard representations with accuracy and detail.

Students will understand numbers, multiple ways of representing numbers, relationships among numbers, and number systems.

5.N.4 Create equivalent fractions, given a fraction.

NCTM Standards:

Number and Operation Standard

Understand numbers, ways of representing numbers, relationships among numbers, and number systems.

Compare and order fractions, decimals and percents efficiently and find their approximate locations on the number line.

Activity:

The teacher will complete one example of the “Equivalent Fraction Game” game with the class (http://www.shodor.org/interactivate/activities/EquivFractionFinder/). The game asks students to divide a square into sections using rows and columns. Then, by clicking on each section, a portion of the square can be colored in to make an equivalent fraction to the one the computer generated. Students’ answers can be checked for accuracy by the computer by clicking the check button. A score and percent accurate is automatically generated by the computer by asking the game to keep score.

Assessment:

Successfully complete eight “Equivalent Fraction Game” games with 85% accuracy. The students will be asked to successfully complete at least eight games, keeping score on the chart provided. Students will be recording the fraction given, along with their computed equivalent fraction, and their computer generated score.
Appendix D

Equivalent Fraction Finder

- Use the +column box and the +row box to divide the shape into sections.
- Then click on each section you want to color in so that your fraction is equivalent to (matches) the computer's fraction.
- Click "check" to see if you are correct.
- Repeat this for the second shape.
- Complete at least eight games.
- Don't forget to keep score, write down your fractions for each shape and record your totals.

<table>
<thead>
<tr>
<th>Game #</th>
<th>Red Shape</th>
<th>Green Shape</th>
<th>Blue Shape</th>
<th>Score</th>
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<td>Completed more than eight games with at least 85% accuracy.</td>
<td>Completed eight games with at least 85% accuracy.</td>
<td>Completed seven games with at least 85% accuracy or eight games with less than 85% accuracy.</td>
<td>Completed less than seven games with 85% or less accuracy.</td>
</tr>
</tbody>
</table>
Appendix E

Post-Test

1-(1M). Which of these is in order from least to greatest?

A) \( \frac{1}{2}, \frac{1}{3}, \frac{3}{4}, \frac{5}{8} \)  
B) \( \frac{5}{8}, \frac{3}{4}, \frac{1}{2}, \frac{1}{3} \)  
C) \( \frac{1}{3}, \frac{1}{2}, \frac{5}{8}, \frac{3}{4} \)  
D) \( \frac{3}{4}, \frac{1}{2}, \frac{5}{8}, \frac{1}{3} \)

2-(3M). What fraction of an hour is equivalent to 45 minutes?

A) \( \frac{2}{3} \)  
B) \( \frac{3}{4} \)  
C) \( \frac{4}{5} \)  
D) \( \frac{1}{2} \)

3 -(6M). If my mother gives me $10.00 and I spend two-fifths of it at the mall, what fractional amount of my money do I have left?

F) \( \frac{2}{5} \)  
G) $2.00  
H) \( \frac{3}{5} \)  
J) $6.00

4 – (10M). In Anne’s class, 6 out 24 students are wearing glasses. What fractions of students are not wearing glasses?

F) \( \frac{6}{24} \)  
G) \( \frac{3}{4} \)  
H) \( \frac{1}{2} \)  
J) \( \frac{1}{4} \)
5 - (1F). \[ 23 \times 16 = \]

A) 39  
B) 368  
C) 218  
D) 1241

6 - (3F) Which number could be written on the line to make the number sentence below correct?  
\[ 2 \times 10 > \underline{\_ \_ \_} \times 5 \]

A) 3  
B) 4  
C) 7  
D) 20

7 - (4F) Lee placed 4 shapes together on his desk. He put them in this order, from top to bottom:
- hexagon
- trapezoid
- rectangle
- parallelogram

Which diagram shows the order of Lee's shape?

- [Diagram F]
- [Diagram G]
- [Diagram H]
- [Diagram J]
Appendix E

8 - (10F). Annie discovered a multiplication pattern. She wrote the number sentences below to show the pattern. What number should go in the box to complete the last number sentence?

\[
\begin{align*}
40 \times 101 &= 4,040 \\
71 \times 101 &= 7,171 \\
59 \times 101 &= 5,959 \\
\square \times 101 &= 2,828
\end{align*}
\]

F) 22  
G) 28  
H) 82  
J) 88

9 - (12F). Susan quickly estimated the product of 84 \times 18 this way:
- She rounded each number to the nearest ten.
- She multiplied these new numbers together.

What was Susan's estimate?

F) 1,500  
G) 1,512  
H) 1,600  
J) 16,000

10 - (14.) What is the rule?

<table>
<thead>
<tr>
<th>Input</th>
<th>Output</th>
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</thead>
<tbody>
<tr>
<td>9</td>
<td>99</td>
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<tr>
<td>10</td>
<td>110</td>
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<td>11</td>
<td>121</td>
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<tr>
<td>12</td>
<td>132</td>
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</tbody>
</table>

F) add 11  
G) add 90  
H) multiply by 11  
J) subtract 100
Appendix E

11 – (18F). Place the fractions below in order on the line.

1/4  1/2  1/3  9/10

12 –(13M). Mrs. Duffy sent out Mr. Duffy to pick up some ingredients for their dinner. She asked him to purchase 5/2 pounds of potatoes. He thought about this and suggested she reword this as a mixed number. What mixed number did she reply with?
A) 3 1/2  B) 2 1/2  C) 5 1/2  D) 4 2/5

13 – (16M). Mrs. Lincoln does her laundry every 4 days. She washes the car every 6 days.

Part A
Mrs. Lincoln did her laundry and washed her car today. What is the least number of days that will pass before she will do her laundry and wash her car on the same day again? Show your work.

Answer: __________

Part B
Explain how you found the answer Part A and why you took the steps you did.
Appendix E

14 – (17M). Part A - Using the line below, create a hexagon.

_____________________

Part B – Below, design a shape that is 2 sides less than the one you made using the line above.

What is the name of your second shape? ________________
Appendix E

15 – (19M). Here are the coordinates of 3 out of 4 points of a parallelogram.

(-50, 10)
(-10, 10)
(-20, 40)

A.) Locate and plot the coordinates above

B.) What is the coordinate of the missing vertex of the parallelogram?
Answer: ______________
Appendix F

Math: Multiplication Facts Timed Practice

When you practice basic multiplication facts for speed and accuracy, you improve your ability to solve problems in which multiplication computations are needed.

You will need a pencil and a timer with a second hand. Set the timer ... and go.

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When you practice basic multiplication facts for speed and accuracy, you improve your ability to solve problems in which multiplication computations are needed.
### Multiplication Facts Timed Practice (cont.)

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<td>X 5</td>
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**Math NAME:**

**Multiplication**
Appendix G

Lesson Study Observation Protocol

Pre-Lesson

Background Information:

Teacher ____________________________________________
Observer ____________________________________________
Date of Observation ____________________________________________
Lesson title ____________________________________________
Subject/Grade ____________________________________________

Demographics:

# of students _____ # of male students _____ # of female students _____

Lesson Focus (circle one):

Engage Explore Explain Extend Evaluate

Lesson Emphasis (check all that applies):

Engage

○ Providing “hook” for lesson introduction
○ Demonstrating a discrepant event
○ Uncovering misconceptions
○ Assessing prior knowledge
○ Demonstrating a principle or phenomenon

Explore

○ Providing an opened-ended investigation
○ Designing student investigations
○ Recording data/collating evidence
○ Following prescribed steps of a laboratory
Appendix G

Explain
- Introducing new concepts
- Learning new vocabulary/facts
- Presenting background content information

Elaborate
- Providing problem-solving activity
- Completing an extended investigation
- Following prescribed steps of a laboratory
- Applying exploration to real-world situation

Evaluate
- Answering textbook short and/or open-ended questions
- Reflecting on readings and problems
- Writing reflections in a journal or notebook
- Preparing a oral or written presentation of evidence
- Completing homework sheets
- Completing performance assessments
- Making entries to a portfolio

Classroom Instruction (Check all that applies):
Indicate major materials resources used during the lesson
- Print materials - commercial textbook
- Print materials - teacher-made
- Print materials - trade books, magazines, etc.
- Hands-on materials - commercial kits
- Hands-on materials - district-produced kits
- Hands-on materials - general laboratory supplies
- Hands-on materials - models
- Technology resources - computers
- Technology resources - calculators
- Technology resources - maps, charts, etc.

Structure of student work:
- Whole group
- Small group
- Pairs
- Individual

Student Engagement:
- Entire class is engaged in the same activity at the same time
- Groups of students are engaged in different activities at the same time
Appendix G

Class Discussion:
- Whole group lead by teacher
- Whole group lead by student(s)
- Small groups

Room Layout:

Illustrate the classroom layout. Include doors, windows, teacher desk, student desks, lab tables, shelves, etc. During the lesson record the names and gender of students, the path the teacher takes, location of supplies or materials (if appropriate), areas of congestion,
Appendix G

During the Lesson

Comments: Record the time and observation throughout the lesson. Capture the salient interactions between the teacher and the students and among students as they work in groups.

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Appendix G

Post-Lesson

Rate each of the indicators from 1 to 5 for all categories. A rating of 5 indicates a “high” score and a rating of 1 indicates a “low” score. Your ratings and comments form the lesson will be used for the post-lesson reflection.

Lesson Design:

- The strategies of the lesson contributed to the purpose of the lesson. 5 4 3 2 1
- The materials of the lesson contributed to the purpose of the lesson. 5 4 3 2 1
- The lesson design encouraged student engagement. 5 4 3 2 1
- The lesson provided adequate instruction in completing the task. 5 4 3 2 1
- Adequate and appropriate materials were provided. 5 4 3 2 1
- The pace of the lesson was appropriate. 5 4 3 2 1

Content:

- The content was appropriate for the lesson. 5 4 3 2 1
- The information presented during the lesson was accurate. 5 4 3 2 1
- The information presented during the lesson was relevant to the students. 5 4 3 2 1

Engagement:

- Students were engaged and involved during the lesson. 5 4 3 2 1
- The lesson provided an opportunity for collaboration. 5 4 3 2 1
- The lesson challenged students’ abilities. 5 4 3 2 1
Appendix G

Lesson Modifications and Areas for Improvement: