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Technology in Differentiation: How to Integrate Technology to Support Students of Low Readiness

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With technology becoming more and more prevalent in today's classrooms, it is increasingly important to analyze both its uses and usefulness. This article shows ways of integrating technology as a support tool for students struggling within a math classroom. The observations and lessons took place within a high school in which every student has a district laptop. Support was accomplished through the use of PowerPoint as an online resource to be used at home, pre-assessments meant to highlight misconceptions or missing skills, and interactive online programs designed to bolster ability in the areas of algebra, geometry, and logic. Results showed an overall increase in performance, with several students moving from a D to a B within the experimental period. Analysis of results shows that online notes were most prized by students, whereas the teacher deemed the use of pre-assessments as most important.
# Table of Contents

- **Introduction** 6
- **Literature Review** 8
  - The Push of Technology within Schools 8
  - Technology Classes versus Classes using Technology 9
  - Technology for Technologies Sake 10
  - The Need for Professional Development 12
  - Technology and Professional Development 13
  - Concerns about Inclusion in the Classroom 14
  - Inclusion and Differentiation 16
  - Technology within the Differentiated Classroom 18
  - Technology and Assessments 20
- **Methodology** 24
  - Population 24
  - Instruments and Materials 25
  - Data Collection 28
- **Results** 30
  - Changes to Methodology 30
  - Analysis of Grades 31
  - Journal 32
  - Professional Feedback 33
List of Tables

Table 1: Breakdown of Student Grades Compared To Previous Semester  44
Technology is becoming more and more pervasive in today’s society. Unlike several years ago, the price of computers has declined to a point that many students either have a computer at home or have access to computers on a daily basis. With the advances and availability of such technology, it is up to educators to train students in its use outside of the classroom. In this case, training can include everything from citing and use of online sources to application training (e.g., Excel, PowerPoint) to simple communication and discussions posted by the teacher. This paper demonstrates how forms of technology can be effectively used within and outside of the classroom, increasing students aptitude in various subject areas. It also shows negative ways that technology can be used to create lecture-based curriculum. More specifically it delves into inclusive classroom settings, where students of various readiness levels are brought together to learn. How can a classroom support every learning level, making the concepts more understandable to students of low readiness though the use and analysis of available technologies? Any increase in student achievement would help to promote more research combining both fields of study.

This study created a classroom in which struggling students have training programs within the classroom. Outside of the classroom, online notes and examples were used to help homework and study. Finally, a direct discussion link to the teacher
helped answer student questions while enabling the teacher to modify curriculum according to their needs
Literature Review

When analyzing the increasing use of technology in modern classrooms, it is important to also integrate the different types of technology. Historical and modern trends in technology will help to describe the incorporation of technology into state learning standards. Ways in which technology can be used incorrectly or inefficiently within the classroom will be introduced, as well as reasons behind such incorrect usage. This research will find answers to the question of technology integration, and whether it is indeed able to help in the support of students of all learning levels.

The review will then discuss trends towards inclusion as well as the need for differentiation within the classroom. Since differentiation is such a broad topic, the general principles of differentiation will be focused on, as well as where these principles can be connected to technology. Specific types of technology that are considered to be more specifically beneficial to students of low readiness levels will be discussed.

The reasoning behind such a literature review is the fact that while there is much research on the uses of technology as well as the need for differentiation in today’s classrooms, there are not many articles that tie both ideas together. By researching both ideas, the hope is to be able to apply the resultant connections within a classroom.

The Push of Technology within Schools

The fact that technology has become increasingly prevalent is no surprise. Analysis and interviews by Dugger (2007) have shown that as of 2007, 40 states have reported education in technology as part of their state framework of education. This was an increase from 2001 when only 30 states reported that their education framework
included technology. It could be inferred that states are becoming increasingly interested in teaching about technology. However, analysis of mandated state requirements of technology classes show a different picture. Only 12 states reported a mandatory education in technology (Dugger, 2007). One explanation was that many of the technology classes are considered to be electives. Another was that district curriculum itself could make these courses mandatory. The data found above was collected by the International Technology Education Association (ITEA), which has a series of guidelines for schools to follow when teaching technology in the classroom. Most states said they followed or used these Standards for Technological Literacy (STLs) as guidelines either state or district wide. Only one state said that they did not use these guidelines (Dugger, 2007). While increase in technology classes are shown to increase over time, there was no correlation in the article between technology classes and technology used within core classes. Therefore while states are increasingly interested in classes dealing with technology, the use of technology within the framework of math or seems not to be as high a priority. Advocates promoting the need for technology based classes cite the idea that technology is now becoming more and more prevalent within core courses. With the increase in technology and the diversity that it brings, one theory is that this will reduce the amount of repetition found in coursework from year to year and enable more technology-specific classes such as engineering (Reed, 2007).

Technology Classes versus Classes using Technology

Many states when interviewed said the ITEA and their standards were a reference for their own technological framework. Looking at the STLs and referenced by the
states, it can be observed that the standards concentrate on types of technological study and skills that can only be assessed within a class devoted to the learning of technology (ITEA, 2000). The general tenor of the writing, however, talks about the connections that technology can have with “core courses” of math, science, English, and history. The research noted that this type of integration is easier in an elementary setting where one teacher can make connections within all subject areas (ITEA, 2000). While the text promotes the creation of connections between technology and other subjects, the wording and phrases underscore that these connections should be made within a technology-based class rather than integrating technology into another subject area. Also, while many of the overarching ideas could easily be integrated into math or science, more specific goals dealing with the idea of production and creation of machines could only really be taught within a technology class. For example, Standard 3 has goal of connecting technology to other subject areas (ITEA, 2000). However, the idea of connecting the science of tendons, joints, and muscles to the creation of prosthetics illustrates a large shift in curriculum. In high school these ideas would have to be taught in two classes with large amounts of horizontal teaming. This could not happen within a school district without prior planning and time to connect these two classes. Also keep in mind that this example is only talking about the connections between technology and science classes. The standards cover all courses with potential curriculum integration.

*Technology for Technologies Sake*

For groups of parents, teachers, and administrators, technology is sometimes seen as a silver bullet in education. By increasing the amount of technology within the
Technology in Differentiation

classroom, students and teachers will be able to incorporate it within their curriculum with minimal training and for maximum student gain. In fact, studies have found that technology by itself does not serve to change teaching styles. The assumptions of parents and school officials when introducing technology may not compare to the reality within the classroom. Cuban, Kirkpatrick and Peck (2001) analyzed the use of technology within two high schools and found that the majority of teachers did not use technology effectively or at all. If a teacher were to use the technology, they were more likely to make it fit within a framework of teaching already found within the classroom. Using a word processor instead of having students write a report is one example used, but it is not such a step to incorporate the use of PowerPoint for strict note-taking or lecture-based classes.

That is not to say this technology cannot be used effectively in student-centered classrooms. Programs which have been shown to engage students in meaningful learning such as practice, drilling, and simulation programs all scored very low in the types of technology used, (Grabe & Grabe, 2004). In this case, however, teachers were not seen as experts in the use of technology. Instead, it was the students who often provided instruction to classmates and created valuable tools to use within the classroom (Cuban et al, 2001). From these results, several generalities can be drawn. First, when teachers are just handed technology they are likely to ignore it. If they do not ignore it, they usually convert the technology to fit with the subject matter and not vice-versa. The second and more positive idea is that students are able to draw from outside experience in the
planning and implementation of technology with the classroom. Many students were able to teach skills or use prior knowledge to help complete technology driven projects.

*The Need for Professional Development*

When students are able to teach technological skills, it also means they are more able to tell if technology is being successfully integrated into the classroom. Unsuccessful integration becomes quite apparent if the teacher misuses or forces technology into the curriculum. Results showing this type of poor integration indicate that more professional development is needed to give teachers tools for change within the classroom. This idea is made more intriguing by the fact that teacher age was not a factor when talking about technology implementation, which could again underscore the need for professional development no matter the age of the teacher (Cuban et al., 2001). That is not to say that there were no success stories within Cuban’s article. Even without the professional development, some teachers had the drive to integrate technology within their classrooms. Teachers who successfully modified their curriculum around technology saw a decrease in lecture or textbook-based work and increases in student based activities.

With district or state-based initiatives for technology increasing, there is also the drive for teachers to adopt new technologies within the classroom. Again, lack of professional development by the teacher has the potential to make technology harmful rather than helpful. In interviewing students, several observe that teachers use technology merely for the sake of using technology (Bell, 2007). PowerPoint in particular was seen as a medium that teachers use badly, probably because of the ability
to use it when delivering lectures. Hopefully technology should not be seen as an impediment within the classroom. Rather, if technology is used in the classroom simply because it is technology, this does not help either teacher or students. Again, there is the idea that technology should be seen as a tool, not as a miracle cure for the classroom.

Technology and Professional Development

The need for professional development is the prevalent topic in an article by Matxan and Edmunds (2007) in which they analyze a program geared toward implementing technology into instructional practices. The program itself used a student-centered approach as a basis for technology integration. One conclusion of the article was that after teachers finish this type of program, their classrooms followed an approach more closely in tune with the ideals found in constructivism. The program was more rigorous than most technology adapted development, requiring seven days of training for three to five teachers in a given school. Of those seven days, five were given over to initial training while two days were used within the school year. Specific changes in teaching were noted, with one teacher noting how students became more interactive with one-another when using technology in the classroom (Matxan & Edmunds, 2007).

Compared to other articles in which technology is introduced without development, the increase in successful change is pronounced. This shows that technology can indeed change teaching styles. While only a few teachers changed their teaching styles and practices in an extreme way, the trend toward constructivism was apparent. This shows the positive impact that technology can have within a classroom, but only if coupled with the professional development of the teacher in its use.
Concerns about Inclusion in the Classroom

One of the buzzwords for education professionals is classroom inclusion. This started out as the inclusion of African Americans into the public schools. While some people still see this type of inclusion still lacking in the public school system (Kantor & Lowe, 2007), today it is commonly used to talk about students with learning disabilities or non-English speakers. The Americans with Disabilities Act is often seen as a major factor in creating opportunities for students with disabilities. Coupled with the concepts and regulations for schools found within the No Child Left Behind Act, schools are paying more attention to mainstreaming classes. This involves the placement of students with learning disabilities into regular classrooms for part of the day. Concerns of parents of these students arise, however, when talking about classroom expectations and the types of teaching found in regular classrooms. Parents become worried that their children will be pushed further and further behind if they do not get the support that they need (Leyser & Kirk, 2006). Within a classroom composed of special education students, their child was able to get more individual support. There is also a concern that teachers will lump all learners together and assess work based not on the individual but rather as a class average. The age of the student and the severity of their disability were two major factors in whether or not the parent believed that mainstreaming was the best option for their child (Leyser et al., 2006).

With regular classroom teachers facing students with disabilities, concerns with professional development can also come up. An article by Brian Cook (2001) analyzed teacher’s perceptions of students within an inclusive class. Visual cues that a student did
or did not have a disability factored in acceptance or rejection by the teacher. One reason behind this could be that learning disabled students often have higher social consciousness, enabling them to hide their disabilities from their peers. It stands to reason that they are also able to hide their disabilities from teachers through the same social interactions. This could be shown by student expression or non-verbal responses to questions. The social cues could also become more disruptive, with students acting out inappropriately within a class. This is usually done in order to draw attention away from their classroom deficiencies to their social or physical strengths. With these types of students, a teacher is more likely to categorize them as problem students or students that they would like to remove from the class. Alternatively, students who have obvious signs of their disability are more often not rejected or categorized for removal, despite similar grades and behavior in class when compared to other students with similar disabilities (Cook 2001). This could be due to the fact that because their disability is more readily recognized and enforced visually, the teacher will more readily excuse their behavior or grades. Parental concerns about the undifferentiated expectations of the teachers towards the students with no obvious disability seem become a more prominent problem when analyzing the responses of teachers (Cook, 2001).

Since it was the behaviors and attitudes of these students that caused teachers to nominate them for rejection, one recommendation is that special education teachers concentrate on these behaviors before mainstreaming students (Cook, 2001). Communication between the special education and the regular education teacher is also seen as a proactive step in helping both students and teachers become accustomed to this
inclusive environment. Professional development was only briefly discussed, but some analysis was devoted to the idea that teachers were more likely to respond with indifference to students with disabilities. The reasoning behind this indifference could stem from the fact that they felt ill prepared to teach these types of students (Cook, 2001). As in previous sections, the need for interdisciplinary communication and professional development is clearly an important factor in enabling teachers to successfully teach mainstreamed classes.

There is another potential problem when talking about an inclusive class, and that is the idea that teachers may tend to combine students with disabilities into one group and label that as differentiation. Within the ideas of differentiation and cooperative learning is also the concept of fairness for the individual as well as individual respect (Tomlinson, 1999). If a student sees another as receiving a simpler assignment or assessment, the instinctual reaction is to ask why there is the difference in the work provided. In doing so, both teacher and students are put in the position where an individual’s disability is broadcast, something the student might not want broadcast to peers. Also, because of preconceived notions of how a student will act in a given situation, the teacher may create a self fulfilling prophecy in which student interactions within class is put under the lens of disability rather than the larger social context of the group. (Broderick, Mehta-Parekh & Reid, 2005) Students who know that an individual is easily responsive to social cues may use that disability to derail the learning process. The teacher’s expectations could also create problems between curriculum and assessment. Many teachers assume that if the student is unable to be assessed; they must also be unable to comprehend. This creates
a focus on learning minimal concepts and having few choices within the classroom. "The result for students with significant disabilities has been that many have experienced severely impoverished curricula, some with little or no exposure to science and social studies content, and with only the most basic and rudimentary literacy and math instruction" (Broderick et al., 2005, p. 199).

**Inclusion and Differentiation**

With proper teacher support through training, communication, and professional development, inclusion can be a powerful tool for teaching. JoAnne Putnam (1998) talked about inclusive classrooms meeting the needs of all students and the powerful experiences and ideas that a diverse classroom can bring. Among inclusion's positive aspects are the increases in academic performance compared to schools using tracking. There is also an increase in social skills and concepts that might not be stressed within a special education classroom, but hold importance both within and outside of the school. The increase in achievement could be considered a reason why many districts are pushing for this type of integration. Group activities and assessments are structured in such a way as to create individual as well as group accountability, one of the proponents of both cooperative learning and differentiation.

Through differentiation, the teacher pare down classroom instruction into the essential skills and principles that all students should know (Tomlinson, 1999). This framework allows the teacher to add and take away outlying concepts and ideas based on the readiness of the learner. In the ideal situation, the teacher would also take into account the differences in learning styles of the student. Teachers would be able to assess
student work and progress, making sure that the fundamentals of the subject are being met while ensuring that students are not becoming confused by an influx of facts and ideas or bored by the slowness of practice questions on subject matter already mastered. Products of student work show the basics needed for the grade level, but also can show off the talents of the learner. For English Language Learners or ELL students it allows the experiences of different cultures to become part of the classroom consciousness, enabling students who might not have mastery of the language to create opportunities to show a different type of mastery (Hoover & Patton, 2005).

With the instruction must come clarity of reasoning, or always asking why we are having students learn the concept or skill (Tomlinson, 1999). While this is seen generally as good teaching practice, often teachers and administrators can become curriculum or test-driven. The result is that students have a tentative grasp as to why such an idea or concept is important, and are unable to make the strong connections needed to build their understanding.

*Technology within the Differentiated Classroom*

By analyzing several unit plans dealing with differentiation (Tomlinson & Strickland, 2005), there are many areas in which technology can prove to be valuable. Individual computer use or group computers can be beneficial in setting group goals and assignments. If students have trouble reading or understanding text, an auditory reminder might be useful along with reading to help in understanding. Many of the strategies used like classroom compacting, tiered projects and assessments can be managed and controlled through the use of simulation programs and PowerPoint. These types of
programs are able to combine the visual, auditory, and kinesthetic components that are often needed to teach the knowledge several different ways (Tomlinson et al., 2007). These changes in the classroom become more meaningful to students with high kinesthetic needs, giving them a sense of control within the classroom that they might not find when doing practice assignments or listening to a lecture.

In order to integrate technology into cooperative learning and differentiation, there needs to be preparation. Software, instructions, and ease of use are all areas that must be addressed before the groups even get onto a computer, but this can also be seen as a way for alternate instruction and may better encompass a student's IEP plan (Putnam, 1998). The use of one computer within a group will also create some of the social choices and ideals that are secondary goals in the cooperative learning process. If use of technology is well thought out and presented, it enables the teacher to allow the technology to take away some of the instructional procedures like general instructions and monitoring general progress within the assignment.

Many students, whether learning disabled or learning English, have difficulty in reading. More importantly, they might be able to read the words but fail to grasp the underlying concepts. Today's technology allows for word processors to speak the words as they are written on the page. Getting the text from a page to digital format is made easier through tools like Infoscan, and for students struggling to understand articles, Microsoft Word has tools that allow the user to summarize major points within the text (Barbetta & Spears-Bunton, 2007). While these programs seem to be primarily article and essay oriented for courses such as English and History, the ability to recognize,
understand, and use vocabulary based in math and science is essential to meet state
guidelines and standards.

*Technology and Assessments*

Another area in which technology can be helpful in the differentiation of a
classroom is the area of assessments. Teachers now have at their disposal computer
assessments that are able to change their questions based on the readiness level of the
students. If a student gets an answer incorrect, the computer is able to note this and in the
course of the assessment and re-evaluate the student using another question dealing with
similar subject matter but easier concepts. At the end of the test, both students and
teachers are supplied with a general progress level and feedback on the incorrect
questions. Accelerated Math™ (AM) is a continuous math assessment tool that allows
the teacher to monitor progress on a daily basis (Ysseldyke & Bolt, 2007). The feedback
that is received would normally take a teacher a long time to produce on an excel
spreadsheet. More importantly, the ability to have immediate feedback when compared to
the standard wait for corrections means that students are able to immediately know if they
understood the material. It can be assumed that along with the grade as feedback,
computer programs are also able to suggest areas of study that the student might still be
weak in. This would mean that the teacher is more able to individualize instruction as
well as discover if the instructional process within the classroom is in need of change. As
previously mentioned, continual monitoring and assessing student needs is a fundamental
principle within differentiation. Students using programs like AM saw significant
increases in learning growth when compared with previous years without the program (Ysseldyke et al., 2007).

Web-based instruction is also on the rise, due in part to the increasing role communication in technology is having in everyday life. Within a differentiated classroom, both students and teachers collaborate on the objectives and goals of an assignment. Homework then should also be a collaboration which has a support structure built within. Drill and practice programs are able to reiterate skills and concepts already taught within the classroom, and can be used to reinforce these concepts and skills that the teacher requires all students to learn (Grabe & Grabe, 2004). Web templates can be modified or expanded for the individual learner based on their interests and readiness levels (Edyburn, 2004). Discussions relating to what students are learning about in class allow students of higher readiness levels to show their thoughts and ideas while allowing the teacher to manage the thread and give each student an equal voice, something that is sometimes not found within a classroom. With online discussions, the teacher can show the change in student perceptions as learners acquire more knowledge. Teachers are also able to guide the discussion through carefully crafted questions and comments (Grabe et al., 2004). Again, support is key when talking about integration and differentiation. For students who need the routine of the teacher talking about the concepts while looking at information at home, use of podcasts have increased in college and high schools (Gordon, 2007). The podcasts themselves are created by the teacher and posted online, giving students who need more time or who were not able to attend class the opportunity to listen to the teacher’s explanation while reading about concepts and examples.
For technological use in higher-order thinking, Chen and Bradshaw (2007) created an experiment in which an ill-structured question was given to several groups of students using web-based learning. Support in the form of guiding questions was given to only some groups, and the questions themselves were different. One type of questioning dealt with strict facts, analysis of basic statements, or questions whose answers should be found directly within notes. The other type attempted to ask overarching questions designed to connect the ill-structured question with concepts and ideas already known. The result is the integration of past knowledge with new understandings enabled the students to create more meaningful answers constructed around the original question (Chen & Bradshaw, 2007). This again underscores the importance of the teacher being able to facilitate learning both within and outside of the classroom.

The technology that is being used in today’s classroom is increasing as more and more articles analyze its effectiveness. Having the technology and being able to use it, however, are two different themes addressed within the review. Educators seeking to use technology to promote old classroom systems and styles should be aware of the ever-increasing drive to create more student centered, constructivist classrooms. Professional development is seen as essential in order to use technology effectively within the classroom, and use of these development opportunities shows a noticeable and positive change in teaching styles. District level trends towards inclusive classrooms only reinforce the need to use technology to successfully teach to the various learning styles and handicaps found within these classes. As the standards for technology become more
integrated into different subject areas, the training for teachers must be increased dealing with said technology in order to improve the quality of teaching. With the increase in technology and the drive for more integration within the school, support for both the teacher and the lower level students must be addressed within and outside of the classroom.
Methodology

The lesson plans took place in early February 2008, the beginning of the second semester of the high school. One class was used, with teacher observations and analysis of resulting class-work, homework, and assessments. Online materials and use of technology during this time were given to technology support staff as well as administration for brief analysis.

Population

The class chosen for the research consisted of 30 students; 15 females and 15 males. The original teacher quit three days into the school year, and another teacher was in charge of the class for three weeks before a permanent teacher was found for the year. The students were not separated during that time. Of those 30 students, there were 24 freshmen, one sophomore, four juniors, and one senior.

The course itself was called Integrated 2, and was an algebra-based math course. For a freshman to take this course required either placement in an honors class in middle school or parental involvement. The course itself was designed for sophomores. 23 out of the 24 students had the same schedule of classes in middle school and were sharing many of the same classes in high school. These students, like many high readiness students who have stayed together for years, were very socially connected to one another. The juniors and seniors found within the class had already failed the course the previous year, and were taking the course for the second time. The one sophomore had neither failed nor
passed the previous freshman course, having transferred into the school their sophomore year.

The freshmen also showed various readiness levels. While most freshmen were placed there due to previous coursework, one student was placed within the class on the basis of scheduling, and did not have many of the requisite fundamental skills the course required. One freshman had severe vision impairment requiring special seating. Two other freshmen had slight forms of autism (Aspergers). Of these two, only one had an IEP. The IEP, coupled with a study skill class, enabled additional time to complete any assessments or coursework not finished within the class period.

The classroom itself was fairly small, originally designed as a temporary structure several years ago. The entry to the room was in the back of the class, next to the teacher’s desk and bookcase. Whiteboards were positioned in pairs along two of the walls. The wall at the front of the room had a television mounted in the corner and a manual pull down screen to project any images. Students sat in pairs in chair-table combinations, 4 pairs across and 5 chairs deep. Technology-wise, the classroom also contained a projector and a device used to display pictures or notes on the screen. Transparencies were not needed for the device.

*Instruments and Materials*

The research took place during four, 115-minute classes and two, 55-minute classes. Before the research, students were required to bring their textbook and notebook into the class on a daily basis. Each student was issued a Macintosh laptop when entering the district unless he or she chose not to receive. Several students not in the class no
longer had laptops because they demonstrated a lack of responsible behavior. In order to create a sense of ownership and responsibility within the classroom prior to the differentiated curriculum, students were required to obtain a two-pouch folder for classroom assignments. A plastic sheet protector was also added to the inside of each folder, and a large label showing each student’s name added to the outside. The sheet protector contained individualized information about the student, most importantly his or her letter grade as well as any missing or incomplete work. The idea was to give individual instruction that was not advertised to the entire classroom. While students knew that their assignments were different from one-another, it was hoped that this would decrease the amount of time spent discussing what was fair.

The folders were updated daily as part of the beginning ritual of class. Students were not only able to write down how they had done on previous assessments or work, but also to look at and understand their individual goals for the day. Classroom-wide goals were also placed upon the side whiteboards as well as what types of work students would be doing that day. Classroom time followed a four-step process. The first step consisted of a warm up question dealing with the previous day’s lesson (Appendix A). This was used to ensure mastery of the concepts taught previously. Folders were passed out and each student looked over work and entered individual grades. Following the recommendations found within the folder, individuals then either went over part of the notes from the previous lesson online, completed practice problems, or engaged in a pre-assessment of the material that would be learned that day. Homework was stamped by the teacher and placed within the folder to be collected at the end of the period.
The bulk of the period consisted group activities as inquiry-based as possible within the confines of the skills and understandings of the curriculum. This was guided by the teacher, who moved around the groups asking generalized questions about what groups had learned and what specific skill set they were completing. Students were allowed to ask the teacher questions only after they had asked the group. Each group also could use a large whiteboard on which they put what they had learned, allowing the teacher to notice which groups were struggling and which groups were moving on to new skills. After a brief lecture in which the teacher asked for feedback on learning and wrote group discoveries on the board, students moved into individual activities found either online or on worksheets (Appendix B). This activity was specifically tailored to the individual and followed basic, intermediate, or advanced level based on prior achievement. This could be changed during the class if the teacher noticed a mastery of the concept during the group phase. The last 10 minutes of class was a post assessment in which each student was asked one basic, intermediate, and advanced question. Students were encouraged to fill in as much information as possible for all questions.

Homework was also assigned on a classroom basis. However, there were several different ways a student could complete his or her work. The homework itself covered all three levels of achievement, and PowerPoint presentations consisting of notes and practice problems with solutions were made available online (Appendix C). This allowed the students to differentiate their own learning if they had trouble answering the questions without help. Email and an open discussion area online also allowed students to ask the teacher if there was a particular question that was not understood, which in turn enabled
the teacher to reply that night or discuss the concept with the student during the warm-up part of the next class.

During periods in which a quiz or test was planned, the classroom procedure changed. No new material was covered during those periods until after the quiz or test, and time was spent giving all students practice questions prior to the assessment. Students of a higher level were encouraged to act as teachers, answering questions within their groups. Members of a group would also be asked to put particular problems on the whiteboard, with each step of the problem clearly written. After the assessment, there was a general period in which students could ask questions about different sections, or the teacher could go over questions while the assessment was still fresh in the students' minds. All major assessments were handed back the next class period.

Data Collection

Data was collected from three sources: teacher, student, and outside professionals. The teacher's data came in the form of a reflective journal listing what activities were done that particular day as well as any comments about the class in general. Items that the students were confused about were analyzed and ways to correct these problems discussed. Since differentiation, integration, and technology were the primary components of the research, computer programs or web-based links used during the period were discussed as well as the observed impact these technological tools had on the students. Student data dealing with classwork, homework, and assessments were taken during this time as well as prior to the research. Individual assignment grades were entered into a spreadsheet and mapped over the research period as well as the overall
grade for this six-class period of time. Absences and general classroom behavior were also noted. Students were pre-assessed as to what they understood prior to the beginning of the research period. They were then given a similar assessment after the research was completed.

Towards the middle of the research period, a teacher within the school was asked to come into the classroom and observe the learning behavior and general tenor of the class. This teacher had a background in both differentiation and integration. An observation form was completed during the class itself. After the class, the teacher and observer discussed the relative merits of the lesson as well as ways the class could improve. The observer filled out the same form on the last day of the research period and noted any changes made to the lesson as a whole.
Results

The results of this experiment showed an overall increase in the quality of the student grades. Out of the handful of students that were struggling during the previous semester, a few exhibited similar grades while many increased their average by over ten points. The reason for this increase, unfortunately, remains uncertain. While some of the online tools such as the PowerPoint notes and examples were lauded and used by students, the discussion and communication based tools were not utilized as much or at all unless the teacher specifically directed students to create a response as part of the homework.

Changes to the Methodology

Two high-readiness students transferred out of the class in the transition from the first semester to the second, and one ELL student was added to the roster. These students were removed for grade comparison. One student was absent for the entirety of the experiment due to a lingering illness. Another student was removed from the experiment because of her refusal to do classwork, which then turned into an administrative action.

A second section of the same class was added to the courses taught during this period as well. This section was comprised of 13 students, most of which were sophomores and juniors. Since little was known of these students, there was less chance for truly individual instruction until well into the experiment. However, it should be noted that they did also receive the same general instruction and support as the other class, and were able to provide feedback on the tools used within the class even if their grades were not analyzed.
Finally and perhaps most importantly, there was not able to be a classroom observation by the teacher alluded to in the previous methodology due to schedule conflicts. Instead a technology integration specialist, or TIS analyzed the online sections and programs used in this unit as well as how the technology was presented to the class. The PowerPoint portion of the unit was also analyzed and commented on by the principal of the school.

*Analysis of Grades*

In looking at the grades and comparing them to the previous semester, the data during the original experiment is very different than that after the experiment. While the previously struggling students managed to increase their grades significantly other students found their grades trending downwards due to poor assessments (Table 1). This led to a small increase in the class average that could be caused by the extra credit assignment given. While the extra credit consisted of only three points, the fact that these constituted an additional 4% increase in grade. This in turn significantly increased the average of five students. Removal of that grade changes the class average to around where the class was in the previous semester. Since the class average remained unchanged, it could be said that there was no general improvement over the entire class. However, it can be noted that several students who ended the previous semester with Fs Ds and Cs were able to increase their grade significantly, the highest of which was moving from a 56.6% to an 80%. The decreases in grades were mostly involving small trends downward, with the most extreme moving from a 79% to a 62.86%. The low grades were created primarily because of late or missing work, combined in some cases
by a low test score. General trends in the grades show that the students targeted as needing more support were able to improve their grades significantly.

Journal

When looking at the analysis of how the various classes went, some generalities can be observed. The use of a pre-assessment in the beginning of the unit and the subsequent warm-up questions that led to the differentiation of the classes were deemed vital and continued throughout the unit, even though students did not, generally, like this method of differentiation. Most of the complaints revolve around the slow pace of analyzing what students should get the support within the classroom and unfairness in the grading. Students of the higher readiness level liked the idea of Jello, or work that they could do in order to achieve a higher average grade. Jello in this case referred to the logic riddles provided in class that covered both simple math as well as more complicated riddles. Einstein created the Jello riddle, and students had to display their logic steps when finding the answer to the riddle. Technology was seen as a detriment in this case, as the answer to the riddle was easy to find. However, as no points were awarded for just the answer, the problem was mitigated. The use of folders was a success, however the use of individualized instructions and a updated form each day was discontinued very quickly due to issues of time. Instead, students seemed to be able to do just fine with an updated homework and classwork template online that they could download and check off themselves if they so wished.

Overall the online notes were considered a hit with most students, many of them noting that they could use it in conjunction with the textbook if they were absent in order
to catch up with the rest of the class. Online download numbers show that several students were downloading the new version of the PowerPoint every night. It was also seen as an ideal review tool, although many students wondered why they had to take notes of any sort because it was more easily found and downloaded to their computers. The discussion section of the website, however, was seen as a failure, as no student used the section unless it was a specific part of the homework. Assessments and work done with the online programs on the Explore learning website were seen as too simple for most of the students in the beginning of the unit. Later use of the website was more specific to particular groups of students who needed more practice in particular areas.

*Professional Feedback*

The tenor of the reports by the TIS staff and others when shown the PowerPoint was generally positive. Most notably they liked the fact that it showed the unit in its entirety and let the student pick and choose what they wished to study. The principal also talked about the fact that these notes could be refined and changed over time to fit almost any curriculum in any school, which he saw as positive for a beginning teacher. The negative component dealt with the fact that it was not as interactive as it could be. Lack of audio was noted, and many of the animations were simple and often used. Some thoughts on improvement included more practice and sample problems that the students could see and then complete on their own. It was noted that some online programs allow the easy creation of practice problems and links to notes or tips if needed. Since all students have an Ipod or Itunes on their computer, an audio version of the days lecture was also suggested in order to increase the support to students.
Conclusion

It appears that the introduction of an online support system caused an increase in the grades of several students deemed for this experiment to be of a low readiness compared to the rest of the class. Indeed, many of the students who fell into the category of medium or high readiness also achieved increases within the same time frame. Whether this is scientifically significant is more difficult to ascertain. Also there is the question of whether any of the changes made to the class were of a higher significance than other changes, and what this could mean to a teacher seeking to emulate the procedures found above.

Of particular note is the idea that because differentiation, integration, and technology were major components within this unit, this produced a large variety of new and different procedures. This increased the number of changes within the classroom while decreasing the number of controls. The assessments, because they were not differentiated or modified for the individual student may be able to show any ultimate successes or failures in support of students. Since there were only two assessments taken during this time the results cannot be touted as statistically significant. By looking at the grades in general, the observer would be forced to conclude that something indeed did happen during this time for a number of struggling students, but hesitant as to what was the exact cause of this change.

Also while the before-mentioned components of differentiation, integration, and technology were indeed significant, they also were not totally implemented into the classroom. What this means is that while differentiation was taking place, there was not
the total differentiation that can be found in many books dealing with differentiation (Tomlinson, 1999). Indeed, the objective here was to try to create a type of hybrid, utilizing the beginning components of what could become an entirely differentiated classroom given the necessary diet of time and teacher willingness. The primary goal, however, was to give technology more of a role in daily and nightly subject matter. Hopefully, this would enable struggling students to gain aptitude in the requisite math skills of the unit. This goal was accomplished, showing significant student feedback, especially in the area of PowerPoint and the use of this program to underscore specific skills and strategies to solve problems (Edyburn, 2004). This connects to the idea that if a teacher is using technology they must be able to prove its effectiveness both within and outside of the classroom. Normally, while all students within the school had laptops, their use within the classroom varied among teachers. The student’s primary interest seemed to be playing games on them.

In general, the students seemed to be very appreciative of both the PowerPoint and the individualized folders. The folders themselves were simple to implement, and tended to bring down the amount of time needed for the teacher to hand work out and for students to hand work in. Students liked them because of the organization and the fact that other students were unaware of their work or assignments and grade. The PowerPoint allowed the students, most of whom were freshmen, the opportunity to see how powerful the technology could be. It also helped support those students who were not yet able to take good notes in class because it showed simplified versions of the notes taken in class. While some teachers would use the PowerPoint in both class and online, many of the
notes taken in class were copied from the whiteboard. This is because PowerPoint is a
cannot be changed easily within the shifting thoughts of the classroom.

The discussion page online as well as student-teacher communication outside of
the classroom was something that students did not take advantage of. Future studies could
try and go in more depth in terms of how these tools can improve student learning. The
idea behind the use of these tools was to make the teacher aware of any misconceptions
or misunderstandings before the next day, enabling modification or changing teaching
styles to fit with the students need. An alternate approach would have been to make this
discussion mandatory contingent on homework review. If students had problems with the
homework, they would need to post before class or else it would not be reviewed. There
could also have been homework-style questions on the discussion board structured to
show individual progress in terms of skills and understandings.

Other ideas would be to create a curriculum for an entire unit or semester to allow
the gathering of increased data on student achievement. If students of a higher readiness
level continue to see a decrease in their grades, the reasons why could become an
important idea to study. Research could specifically target one of the three major tools
used within the experiment. While technology was considered the driving force behind
the research, both differentiation and integration could be increased within the classes
over time. This could be done in a way that allows researchers more ability to study
individual components of the classes more closely, in the hopes of generating more
specific and verifiable results. Another idea not implemented within the class would be
the application of online assessments that allow for immediate feedback for the student
due to the fact that such programs are expensive without district aid (Ysseldyke et al., 2007).

While average classroom grades did not increase significantly during the time of the research, several students of low readiness level showed significant increases in their grade. This coupled with the overwhelming support in the use of online notes and problems signify that the integration of technology should not only continue, but should be expanded. With the increasing positive data behind both differentiation and integration of classroom, technology should be seen as a way to both support these two teaching styles.
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Appendix A: Warm-Up Template

Warm-Up Activity Sheet

<table>
<thead>
<tr>
<th>Name:</th>
<th>Unit:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Answer</td>
<td>Date, Question</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Answer</td>
<td>Date, Question</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Answer</td>
<td>Date, Question</td>
</tr>
</tbody>
</table>
Appendix B: Example of Online Program

Solve the equation $2x + 2 = 6$ for $x$

Click to add counters or cups to the left side.

Model each side of the equation using $x$-cups and unit counters. Click 'Check' when done.
Appendix C: PowerPoint Slide From Homework

Need: Toolbox Skill 9-18 (algebra), 26  p669-670

Rules of Logic

<table>
<thead>
<tr>
<th>Direct Argument</th>
<th>Valid</th>
<th>Invalid</th>
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<tbody>
<tr>
<td>p → q</td>
<td>p → q</td>
<td>If it is a rat, then it is a rodent. It is a rat, therefore it is a rodent.</td>
</tr>
<tr>
<td>p</td>
<td>q</td>
<td></td>
</tr>
<tr>
<td>⊼ q</td>
<td>⊼ p</td>
<td></td>
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<table>
<thead>
<tr>
<th>Indirect Argument</th>
<th>Valid</th>
<th>Invalid</th>
</tr>
</thead>
<tbody>
<tr>
<td>p → q</td>
<td>p → q</td>
<td>If it is a rat, then it is a rodent. It is not a rodent, therefore it is not a rat.</td>
</tr>
<tr>
<td>not _q</td>
<td>not _p</td>
<td></td>
</tr>
<tr>
<td>⊼ not _p</td>
<td>⊼ not _q</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Chain Rule</th>
<th>Valid</th>
<th>Invalid</th>
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</thead>
<tbody>
<tr>
<td>p → q</td>
<td>p → q</td>
<td>If rat then rodent, if rodent then hairy.  Therefore if rodent then hairy</td>
</tr>
<tr>
<td>q → r</td>
<td>p → r</td>
<td></td>
</tr>
<tr>
<td>⊼ p → r</td>
<td>⊼ q → r</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Or Rule</th>
<th>Valid</th>
<th>Invalid</th>
</tr>
</thead>
<tbody>
<tr>
<td>p ∨ or _q</td>
<td>x = 4</td>
<td></td>
</tr>
<tr>
<td>not _p</td>
<td>x &gt; 0</td>
<td></td>
</tr>
<tr>
<td>⊼ q</td>
<td>⊼ x = 4</td>
<td></td>
</tr>
</tbody>
</table>
### Table 1. Breakdown of Student Grades Compared To Previous Semester

<table>
<thead>
<tr>
<th>Previous student grade</th>
<th># of Students</th>
<th>HWK</th>
<th>DLWK</th>
<th>EX</th>
<th>ASSMT</th>
<th>AVG GRADE</th>
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</thead>
<tbody>
<tr>
<td>D or F</td>
<td>5</td>
<td>76%</td>
<td>78%</td>
<td>0%</td>
<td>72%</td>
<td>70.72%</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>64%</td>
<td>93%</td>
<td>0%</td>
<td>50%</td>
<td>78%</td>
</tr>
<tr>
<td>B</td>
<td>8</td>
<td>79%</td>
<td>95%</td>
<td>38%</td>
<td>86%</td>
<td>88%</td>
</tr>
<tr>
<td>A</td>
<td>6</td>
<td>100%</td>
<td>96%</td>
<td>38%</td>
<td>89%</td>
<td>96.8%</td>
</tr>
</tbody>
</table>