Can Technology Successfully Support Differentiation?

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Abstract

The development of Mathematical skills in children is critical to their success both in school and as adults. Students need to be able to develop those skills in ways which are both manageable and achievable to them. It is essential, then, that teachers provide curriculums and lessons which are accessible and focused on the specific learning needs of the students. Goals need to be achievable and therefore differentiation within any classroom is essential. This study explores the importance of differentiation and how technology can now become an integral, and beneficial, part of the differentiation process.

Keywords: Differentiation, fourth grade technology, blended learning, rotation model

Can Technology Successfully Support Differentiation in the Classroom?

Introduction

In classrooms today, around the world, we have a huge diversity within the student communities, this diversity includes different cultures, religions, economic backgrounds, as well as different learning abilities. Where one student might excel in the Mathematics curriculum he/she may lag behind in the English Language Curriculum. Today there are students in the classroom that have dyslexia, dyscalculia, dyspraxia, Attention Deficit Hyperactivity Disorder (ADHD), Attention Deficit Disorder (ADD) and a number of other learning differences. Each of these students needs to be able to access the curriculum. A student with dyslexia cannot read and write as well as other students and therefore teachers need to put actions/plans in place to address their difficulties. This was demonstrated clearly in Exley's (2003) research paper on the impact of differentiation for the dyslexic student when he concluded that, "Based on the findings of this research, there are clear conclusions to be drawn. All seven students improved their performance, once their preferred learning style had been established and had been used to teach them specific ways of learning."

Michael Petrilli (2011) states: "By the 4th grade, public-school children who score among the top 10 percent of students on the National Assessment of Educational Progress

(NAEP) are reading at least six grade levels above those in the bottom 10 percent." This means that in one classroom you can have such a large difference in levels in reading but yet you have to ensure that those students who are above grade level are being challenged, and that the students at grade level are making progress, and that those students who are below grade level are receiving the support they need. The same is evident in a Math classroom, sometimes the 'achievement gap' can be even greater in a curriculum area which requires analytical thinking skills. According to the National Center for Education Statistics (NCES), (https://nces.ed.gov/fastfacts/display.asp?id=38 (2015)) "The average scores for 9- and 13-year-olds in 2012 were higher than those in 1973 (25 and 19 points higher, respectively), but the average score for 17-year-olds in 2012 was not measurably different from the score in 1973." When reviewing this data one wonders if the concrete mathematic concepts are taught in the elementary grades, but not the more analytical skills, which are going to be required in the higher grades.

Statement of the Problem

Over the past 15 years technology has developed at such a rapid rate and even though many learning differences have been taken into consideration, it is how the technology is used within the classroom that will determine its success. How teachers are taught new technology is important, however, although many schools invest in the technology, there is no longer funding to train the teachers on how to use the technology. This results in the teachers not using technology correctly, or just not using it at all.

A California public school can have up to forty students in a class, so the learning styles and differences are going to be vast. A teacher in a private school with eighteen students in a class, will experience similar difficulties, whether from language obstacles, cultural obstacles or learning obstacles.

Background and Need

In August, a teacher walks into her classroom of thirty new students. 50% of these students may be ESL (English as a Second Language) Learners, 20% may fall into the category of Students with Learning Differences, 10% may be identified as more able Learners, and the rest of the students may be at grade level, or referred to as 'Average Learners'. Is the teacher going to prioritize her Learners or is the teacher going to find ways of engaging all the students? The California Department of Education (2015) states, "In a standards-based curriculum, effective lessons, units, or modules are carefully developed and are designed to engage all members of the class in learning activities that aim to build student mastery of specific standards." Therefore, it is evident that engagement is the key for a successful mathematics lesson.

A private school 4th grade math classroom has eighteen students in it. Four of the students may be recognized as high ability, one student may be a child with learning disabilities and will therefore be a low ability student in that classroom, and the remaining thirteen students may be average ability students who do find some areas of mathematics more challenging than others. Even though the number of students is low there is still the need for differentiation in that classroom and technology could play a vital role in the learning of the students.

Differentiation has involved a blended classroom model, ability grouping, mixed ability grouping and the teacher working directly with students who find a specific concept challenging. The focus needs to be on how the technology can be introduced and ensure that it is used in a manner which is beneficial rather than as a tool to keep students busy.

Review of the Literature

There are three areas of research pertinent to the research questions:

1) differentiation in the Mathematics classroom,
2) technology to support differentiation in the Mathematics classroom, and
3) Use of the Blended Learning model in the Mathematics Curriculum.

Differentiation in the Mathematics Classroom

The word 'differentiation' has been used, in education, in a variety of contexts over the past few decades. Moyle (2012), in her paper described differentiation as being used to "describe approaches to teaching and learning that commence from students' knowledge, skills and abilities rather than from pre-determined programs of study". It is a way to ensure that all students are able to access the curriculum in an appropriate and productive manner, rather than the teacher directing teaching to one specific type of learner. Mathematics is a curriculum area that can be extremely challenging for students to understand concepts, and, if not understood in the initial phase of introduction, as the curriculum progresses the students develop more difficulties. Hobgood and Ormsby's (2011) describe differentiated by explaining, "Differentiating instruction involves manipulating the teacher-dependent dimensions — those

variables over which teachers have control. But differentiating instruction effectively requires manipulating those variables with attention to the student-dependent dimension — the variables over which teachers have no control, but that make each student unique."

Technology to support differentiation in the Mathematics classroom

In Hobgood and Ormsby's (2011) paper they focused on the types of technology that is suitable for the mathematics classroom, and how it can be used effectively. They referred to flexible groups, not specifically ability focused (unless necessary at the time) and this allowed students to move from group to group rather than always working with the same group of students, thereby becoming demoralized and despondent about their own abilities. This is a great thing to do when looking at the cross-curricula model of teaching and using a variety of curriculum skills within one topic. Goos (2010) discusses how technology needs to 'partner' with the student and teacher and how it needs to, "provide access to new kinds of tasks or new ways of approaching existing tasks so as to develop understanding, explore different perspectives, or mediate mathematical discussions." Differentiation through technology is not a simple process and needs to be planned out. Hobgood and Ormsby's (2011) explain, "As with differentiation by content, using technology to differentiate by process requires first attending to the student-dependent dimension of differentiation. Focusing on student readiness, student interest and student learning profile, yields effective differentiation centered on learners' needs." A student with ADHD who has difficulties focusing on long texts or staying focused might benefit from video-streaming. A student with processing difficulties might benefit from virtual manipulatives in the math classroom. Hobgood and Ormsby's (2011) refer to the The National

Library of Virtual Manipulatives, which is supported by the National Science Foundation, and "is a database of freely accessible manipulatives and tutorials for K-12 mathematics."

Dyscalculia, which is a diagnosed mathematical learning disability, may benefit from the use of technology. Hobgood and Ormsby's (2011) explained that: The use of a hand-held calculator can help students who have difficulty writing numbers in the proper sequence. For students without access to handheld devices, many online calculators offer the same functionality. Alternatively, students with dyscalculia can use spreadsheet programs like Microsoft Excel, which have built-in formatting options to help students organize and see data. The ability to color-code columns or rows of data, for example, can help a student who needs support, to distinguish numbers.

Blended Learning in the Mathematics Classroom

When introducing technology into the classroom there are a variety of models that could be used. The Blended Learning Model is an effective model which can be suited to a variety of different curriculum areas, including the mathematics curriculum. Horn and Stalker (2014) explain how, if implemented correctly, blended learning breaks through the barriers of the use of time, place, path to understanding, and pace to allow each student to work according to his or her particular needs—whether that be in a group or alone, on practice problems or projects, online or offline. It preserves the benefits of the old and provides new benefits—personalization, access and equity, and cost control.

Heather Staker (May 2011) defines Blended Learning as "Blended learning is any time a student learns at least in part at a supervised brick-and-mortar location away from home and at least in part through online delivery with some element of student control over time, place, path, and/or pace." She goes on to discuss the 6 different models of Blended Learning that could be quite effective:

The Face-to-Face Driver model: involves the teacher deciding which particular students will benefit from use of an online resource. This could be used for a small group of students who either require extension learning or students who are slightly behind and need remedial resources.

The Rotation Model: is very similar to the popular 'stations' models used in most classrooms. This is when students are scheduled to complete a specific activity, within a specified time frame, and once that time has passed they move onto the next activity. This Rotation Model is extremely effective as it gives the teacher the opportunity to work with specific groups of students with a focus on a specific area of the curriculum.

The Flex Model: is when students receive an entire lesson from an online source and is focused mainly on students learning independently from the teacher and other students. With this model, qualified teachers are available to help support the student when necessary.

The Online Lab Model: is when students are completing curriculum areas that are not available at their campus and the students are therefore based in a computer lab receiving lessons

from sources that could even be based in another country. There is supervision but not necessarily people who are able to supplement/support the teaching.

The Self-Blend Model: is when students, predominantly high school students, decide to take a variety of courses online in addition to the classes offered at their school.

The Online Driver Model: is when there is one teacher and one specific online driver from where the entire curriculum is taught. Students are not necessarily based on a school campus although some in-person check-ins can take place.

When implementing any form of technology and the Blended Learning Models, it is not only important to have effective technological devices, but more important is to have a clear implementation and usage plan, a professional development for teacher and knowledgeable and reactive technology support.

Summary of the Research Literature

In summary, this study came about due to the need for differentiation within a mathematics classroom and the understanding, and recognition, that technology has become a significant and extremely important aspect of society's everyday life. The idea of integrating the two of them, mathematics and technology, but still ensuring that a secure differentiation program remains in place, that will allow all students to access the curriculum and make progress is imperative. In order for this integration to be successful, there needs to be an implementation model that would integrate the two but still allow the teacher to focus on specific different needs within the classroom. The are many resources available for supporting specific learning needs or

for providing additional support for current learning, however a specific model must be put in place to ensure that an integrated program is beneficial. Models such as Blended Learning, or the Flipped Classroom Model, are effective as they still allow teachers the ability to assess the learning, build on the learning, and even extend the learning.

Research Methodology

So how can technology successfully support differentiation in the class?

Three guiding questions that need to support the overall question are:

1) How can those students who are 'more-able' be challenged, without just increasing the quantity of the work?

2) How can students who are 'less-able' successfully achieve the same learning objectives as the other students?

3) How can the teacher effectively ensure and monitor the progress of all the students?

This study followed a mixed method, qualitative research study that required students to complete both a pre-survey and post-survey to determine their attitudes towards Mathematics and technology. A pre-assessment and post-assessment was also required to ensure accurate measurement of data.

This study took place in a 4th grade classroom in a Hebrew Day School. There were 18 students in the classroom, 7 boys and 11 girls. The mathematical abilities of the students varied across the classroom, some were fluent mathematicians who understand concepts during the

initial explanation, while others required more practical, and visual tools to help with their understanding of new concepts.

It is important to share the structure of the curriculum within the school in order for the reader to gain an overall understanding of the challenges faced by the students. Being a Jewish Orthodox Hebrew Day school means that not only do the students have the Californian Curriculum to cover for Language Arts, Mathematics, Science and History, but they also have a Hebrew Language Curriculum, as well as a Jewish Studies Curriculum.

This divides the 4th graders day into three distinct curriculum areas, of which a typical day consists of three hours of General Studies (for the California Curriculum coverage), ninety minutes of Hebrew Studies, followed by another ninety minutes of Jewish Studies. Whereas the typical public school teacher has a minimum of four hours per day to cover his/her California curriculum, the Hebrew Day School teacher has a maximum of only three hours. The school days for students are longer, and in addition to the General Studies homework, a 4th grade student also has Hebrew and Jewish Studies homework.

This Hebrew Day School has not had a very advanced technology system in place, until 2015 there were twenty laptops in a computer lab. The computer lab was shared between all the grades and therefore access to computers was minimal. There were approximately twenty iPads available which were shared across the school and, therefore, the teachers were never able to have a full class set.

In 2015 the school purchased thirty classroom Chromebooks, an additional ten iPads, and all middle school students received individual Chromebooks. This technology improvement was extremely beneficial, although a few problems were encountered. The most significant problem encountered was that the students had limited technology knowledge such as correct keyboard usage, as well as the understanding of how to use the technology. These were some of obstacles the teacher was going to have to overcome during this study.

The 4th grade class involved in the study consisted of 18 students:

Males	Females	Home Language			Math Level		
		English	Hebrew	Other	Below grade Level	at grade level	Above grade level
7	11	13	2	3	3	11	4

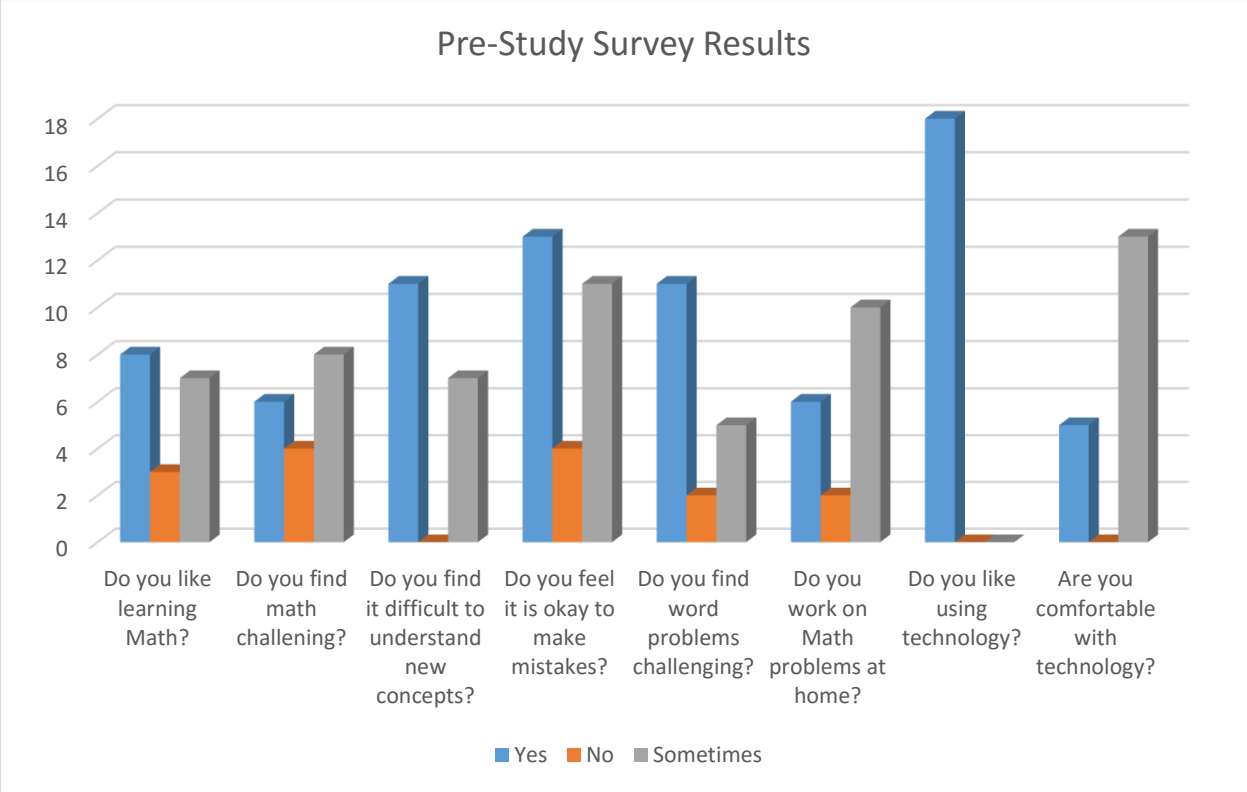
The teacher began with a basic survey to understand what the students opinions were towards both Mathematics as well as Technology. The Survey consisted of eight basic questions and the teacher was able to gather data from that survey.

1. Do you like learning Math?
2. Do you find Math Challenging?
3. Do you find it difficult to understand new math concepts?
4. Do you feel that it is okay to make mistakes in Math?
5. Do you find word problems challenging?

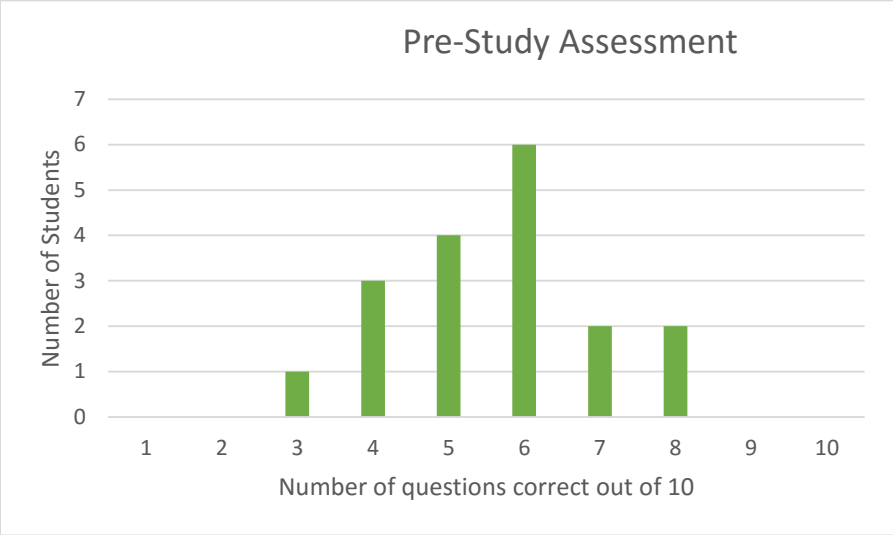
6. Do you work on Math problems at home?

7. Do you like using technology?

8. Are you comfortable with technology?



The project required the teacher to divide the class into five clearly defined student groups. These groups were set-up according to the students' Mathematical abilities, with a focus on 'fractions', and was based on a pre-assessment given to the students prior to the study. The assessment included 10 questions on fractions.



Since there would always be one group of students working directly with the teacher, she would be able to focus on that specific group. This allowed the teacher to target the specific curriculum needs of the students.

The groups were set up according to ability in order to achieve the best results:

Group name	Description
Group 1	Below grade level in mathematics
Group 2	At grade level although some difficulties with fractions
Group 3 & 4	At grade level although difficulties with the application in real world problems
Group 5	Above grade level and require extension. Teacher would like to spend more time on more advanced applications.

The teacher used the Blended Learning Rotation Model and also involved a variety of curriculum areas rather than only focusing on Mathematics. The rotational groups consisted of the use of Mathematical instructional videos, online mathematical games to practice their learning, a typing program to develop their computer keyboard skills, research programs for a language arts project and the another group where students worked directly with the teacher.

Each rotation took 15 minutes and gave each student the opportunity to focus on a specific task without becoming bored. The teacher believed that 15 minutes would also be a perfect opportunity for her to target a specific mathematical area before moving onto the next group.

The groups were as follows:

Activity	Groups				
Online Fraction Lesson	1	2	3	4	5
Working with the teacher	5	1	2	3	4
Online fraction games	4	5	1	2	3
Research project	3	4	5	1	2
Online keyboard skills	2	3	4	5	1

The teacher arranged the grouping in this way so that those specific groups of students, who were struggling with the unit on fractions, would watch the online lesson prior to meeting

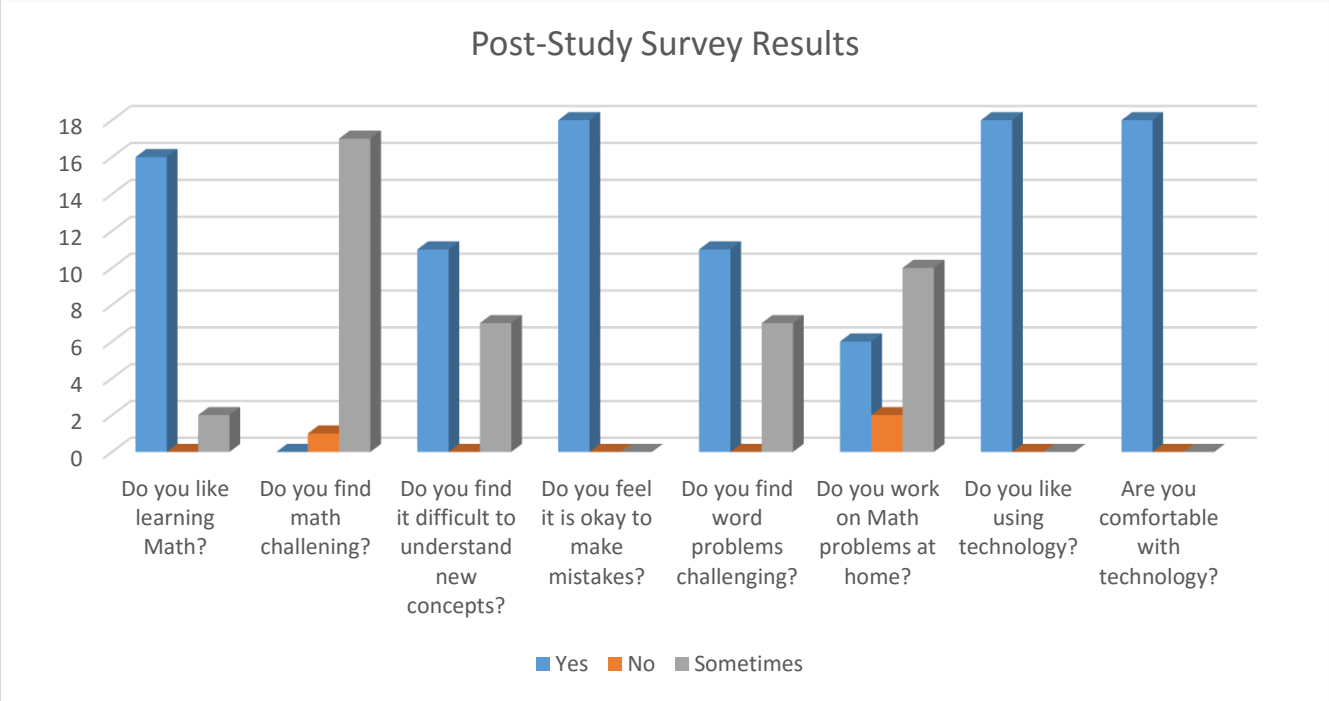
with her. She was then able to reinforce their learning on that specific topic, and then they would work on the online fraction games once they had spent time with her. The more advanced groups would spend more time with the teacher on more advanced math skills, such as application of their Mathematical skills through a variety of more advanced real life problems.

Results and Analysis

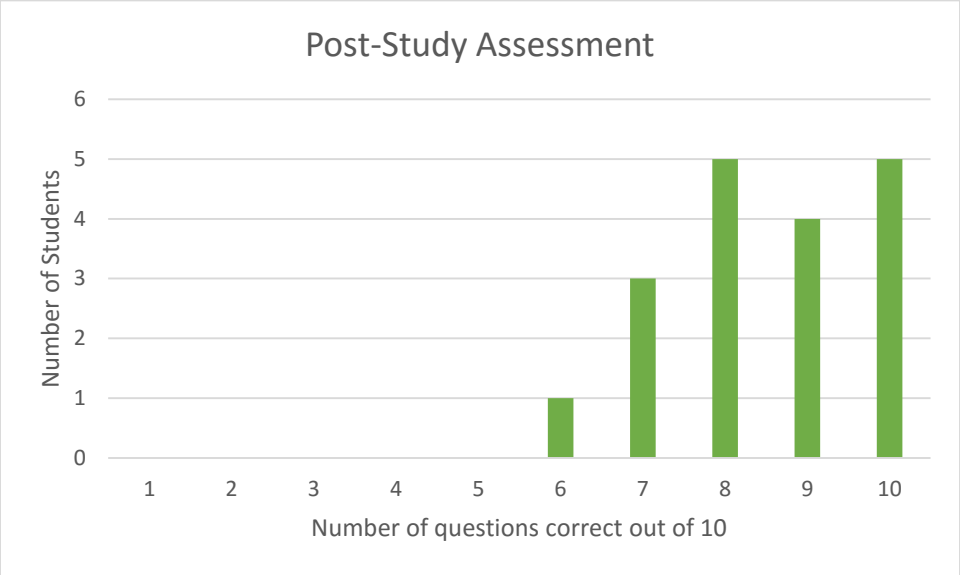
As many people in education know, not everything always goes according to plan. In order to share clear results it is important to discuss both the failures and the successes of this project. The outcomes were learning experiences for not only the students, but also for the teacher.

Day one, the use of the Blended Rotation Model was a great success. The 18 Chromebooks were available to the students, the required websites were displayed on the whiteboard, and the rotation groups were visible to all students. The teacher started with the group of students who were above grade level (Group 5) and their exercises required taking real life mathematical situations and solving them. The teacher was able to have intense educational conversations with the students and the students benefitted from the instruction.

The exercise continued for two weeks, and by the end of the second week positive results were evident. The teacher had been able to perform informal assessments of the students' existing knowledge of fractions, as well as the knowledge they had gained during that week of activities. At this stage the Post-survey was conducted, and its results were compared with the initial survey results to see if the student responses were any different. :

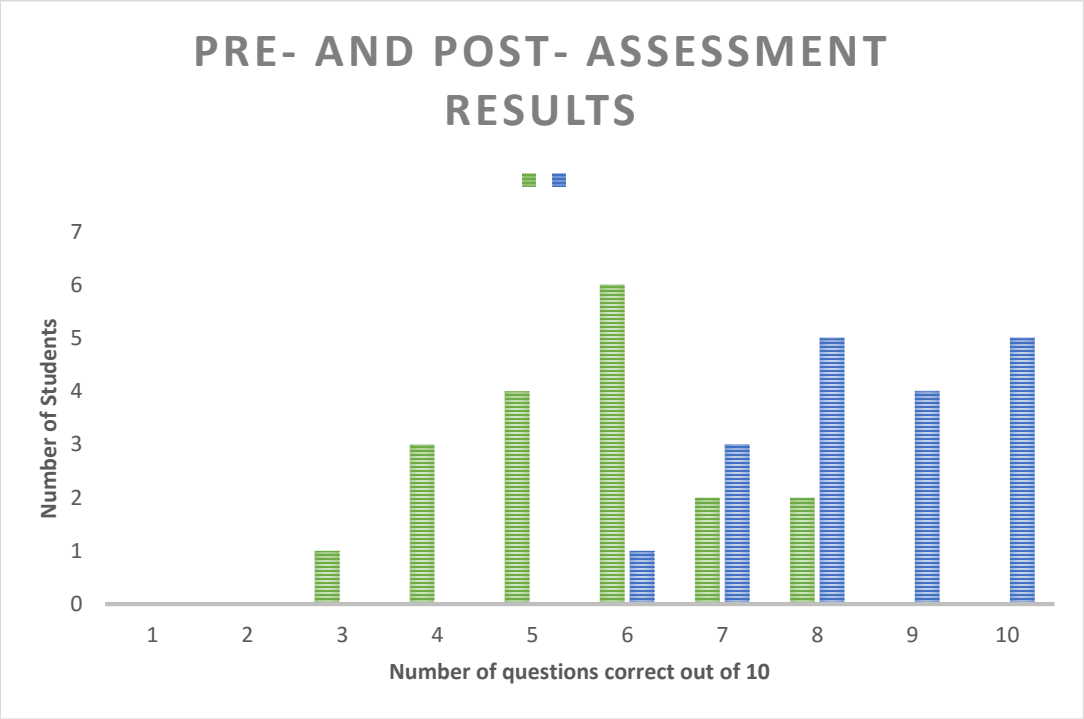


A Post-Study Assessment, with another ten questions involving fractions was performed by the students, and although there were still a few students who did not complete all the questions correctly, they were able to identify the errors.



Outcomes

When comparing the Pre- and Post-Assessment results it is evident that many of the students had a more concrete understanding of the math concept taught.



With the combination of technological tools and a blended learning model, successful differentiation was possible. Each student was able to access the learning in a way which gave them the ability to gain a clearer understanding of the content.

The most interesting outcome from this study was that, according to the post-survey, the students who were below grade level realized that math was not always challenging. And those students who were above grade level realized that not only was math not always easy, but there were different ways of learning it with the technology. With more time available, and since this Blended classroom model is going to continue in this fourth grade classroom, it is believed that the outcomes could become even more evident.

The teacher discovered that the specific online video program used would be extremely beneficial in a Flipped classroom model. The plan is to attempt the flipped classroom model for Mathematics and, due to the engagement of the students, continue with the Blended Rotation Model for not only Mathematics, but also other curriculum areas. For a Hebrew Day School, where time is extremely tight, these models are extremely beneficial and could be extremely successful.

In conclusion it is possible to answer those three driving questions. It is possible to challenge those 'more-able' students without increasing the work load, the 'less-able' can achieve those same learning goals and, through the use of a blended learning model, the teacher can effectively ensure, and monitor, the progress of all the students.

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