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Effects of differentiating instruction through tiered lessons in special education secondary mathematics

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EFFECTS OF DIFFERENTIATING INSTRUCTION THROUGH TIERED LESSONS IN SPECIAL EDUCATION SECONDARY MATHEMATICS

by
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Abstract

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This study examined the effects of differentiating instructing through tiered lessons to see if it would improve student's success in high school special education classes. The study was done in two Algebra II secondary special education classrooms including 17 students in total. There were 5 females and 12 males, all students were juniors in high school and aged 16 or 17 years old. All of the students were classified as either specific learning disabilities, other health impaired, or multiple disabilities including anxiety and depression. The students were enrolled in resources classes for all of their major academic subjects and inclusive classes for electives. Three of the students were in some inclusion classes for academic subjects and two students attended technical school in the afternoon for mechanics and culinary.

The classes were taught by two different teachers, each having the same amount of experiences – about 7.5 years. Both teachers are certified mathematics teachers. The study took place in two Algebra II secondary special education classrooms. Each class is taught by a different teacher, both teachers have 7.5 years of experience and are highly qualified in mathematics. Each classroom also has a teacher's aide. Each teacher's aide holds a bachelor's degree but neither is certified in teaching. The aides have been working in the district for 10 and 6 years and have 2 and 6 years of experience in the math classroom, respectively.

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Chapter One

Introduction

Every student learns at a different pace and has very different abilities. Academic diversity is extremely evident in today's classrooms. Within the same classroom you will find: students with identified learning disabilities; highly advanced students; motivated and unmotivated students; students who meet grade level expectations and students who don't; students of widely varying interest and preferred modes of learning; and students who meet two or more of these categories (Tomlinson, 2003). Pace and ability can vary mildly or drastically for students within the same class and these differences can vary depending on the curriculum content. This variability can make it very challenging for students to learn within a homogenous classroom and requires that teachers differentiate lessons in order for students to find the highest level of success possible. Challenges must be at the proper level of difficulty in order to be and remain motivating: tasks that are too easy become boring; tasks that are too difficult cause frustration. According to Tomlinson (2003), when academic tasks were poorly matched to readiness levels impacts were negative. When tasks are too simple, students become disengaged. When tasks are too difficult, student achievement and feelings of self-worth decrease.

Addressing the needs of all students in a classroom is a key element of the responsibility of being an educator. In order to meet the needs of all student's teachers must get to know students and differentiate lessons that meet their individual needs. Being informed about the background knowledge, experiences, and learning reference of students enables teachers to select learning techniques, strategies and environments that engage students in active learning (Herrelko, 2013). A teacher's role is to guide students

in finding a level of learning that allows them to find success and pushes them out of their comfort zone.

The research questions addressed in this study will be:

Do multi-tiered lessons, that allow students to advance based on readiness levels, allow high school math students to find more success and more motivation to learn?

Does allowing students the ability to self-regulate and advance at their own pace provide for a more enjoyable learning environment?

Does allowing students to work at their own readiness level cause less anxiety and more positive feelings towards math?

What is a Tiered Lesson?

Tomlinson (1999) described tiered lessons as a differentiation strategy that addresses a particular standard, key concept, and generalization, but allows several pathways for students to arrive at an understanding of these components based on interests, readiness or learning profiles. According to Richards & Omdal (2007), tiered instruction is grouping students for instruction based on their prior background knowledge in a given subject area. For this reason, tiered lessons require that teachers have a good understanding of a student's abilities and have a method for assessing student's abilities before beginning a topic in order to accurately group students, as well as at the end of a topic in order to measure effectiveness.

Teachers must also observe students throughout the lesson(s) and takes notes on each student's progress which helps to guide them for a formal assessment. Tier placement is not a permanent position and need not be established by committee or made a permanent part of a student's record. Tiers can change daily as the teacher employs good assessment strategies to identify the needs and achievements of students (Herrelko,

2013). It is also essential to student motivation and success that they understand their placement is not permanent and that they can move amongst tiers each day.

What is Student Readiness?

Student readiness refers to a student's current knowledge and skills and how their readiness affects their ability to advance to the next topic in the curriculum. Often, in a non-differentiated classroom, students are forced to move on to a new topic before they have mastered the current topic. This can be stressful, especially for students in special education classrooms. I found that, when students were assessed on a topic that they weren't comfortable with, they refused to try or, even if they wanted to, they didn't know where to start. In addition, readiness really affects student motivation. When students are given too many of the same tasks and are not allowed to move on, they become bored; students who are asked to move on too quickly become frustrated. A system that allows students to move when they are ready has the ability to be extremely successful and is the idea behind my thesis.

It is important that the processes and products the teachers select respectfully consider the learner' current levels of knowledge and understanding. Determining a learner's level of knowledge before, during and after the instructional period is critical to proper placement of the student in either a flexible learning group or on the learner's own work path. Skill based grouping also ensures that all learners are working at their entrance point into the topic, as well as learning in information while achieving academic growth (Richards & Omdal, 2007).

A positive implication for this would be that students are able to obtain more knowledge and perform better on assessments then they would have using a typical homogenous lesson format.

Another positive implication is that students begin feeling less stressed about mathematics and develop positive feelings in regards to math as a subject and towards their abilities in math. Students may begin to doubt themselves less and stop associating math with failure.

A negative implication is that students recognize the control they have over the pace that they advance through levels and remain at their lowest level possible. Their motivation for this may be to avoid hard work, to obtain high grades and to avoid experiencing failure.

Another positive implication is that teachers will receive professional development. Professional support for teacher is critical to the success of tiered instruction.

Chapter Two

Literature Review

Schools and classrooms continue to be more and more diverse. Students learn at different paces and each student has a unique learning style. In order to reach the majority of students, many consider teaching to the middle of the tactic that allows for the largest number of students to meet the required curriculum standards (Sondergeld et al., 2008). However, this can inhibit many students including: students with learning disabilities, students who are capable of excelling and students who are incapable of learning at the pace of other students. A more efficient way to reach as many students as possible is to differentiate instruction in such a way that many different levels are taught within the same classroom. This prevents students from receiving the same educational experience as their peers and gives each student an equal opportunity to reach his or her learning potential (Sondergeld et al., 2008)

Differentiation is an approach in which teaching is varied and adapted to meet students' abilities. There are many different methods of differentiation; the nature of instruction, the way progress is monitored, and the way students are organized can vary amongst schools and classrooms (Prast et al., 2018). A popular way to differentiate is to group students based on their ability levels and readiness. This can happen both on a large scale, school-wide, using Response to Intervention (RTI), or on a smaller scale, within an individual classroom, using tiered lessons. Tiering or grouping students based on readiness and ability level allows them to work at a pace comfortable for them, with the ability to advance between levels throughout. Major components of differentiating and leveling includes: screening students, instructional planning, instructional methods,

monitoring student progress, students self-monitoring progress, and assessment. Each of these strategies is essential to a successful tiered curriculum or lesson.

School-Wide, Multi-Tiered Systems of Support: Response to Intervention

Response to Intervention (RTI) is a multi-tiered system of support that is focused on providing success for student's school-wide, through organized curriculum, instruction and assessment (Donovan, 2013). RTI uses three or more levels of instructional intervention that are provided to different groups of students based on their abilities. The first tier includes providing the entire population of students with quality and effective instruction and screening for students with progress struggles. Students failing to meet standards are then moved to tier 2 where they will receive additional small group interventions with regular monitoring. Finally, tier 3 includes those who did not find success in tier 2 and may qualify for special education services. RTI is most notably used at the elementary level and there has been much research about RTI as a model for boosting student achievement; but there is little research when it comes to secondary schools and the area of mathematics (Armes, 2009).

Donovan and Shepard (2013) studied the effects of the implementation of RTI in the area of mathematics in an elementary school and middle school. They explored the issues the schools encountered in respect to instruction, intervention and assessment. They used qualitative methods by observing in the schools and conducting interviews. Their results showed that the two schools achieved significant progress in implementing RTI for math instruction. Staff at both school districts reported positive changes including increases in communication among parents, educators and students, as well as increases in staff collaboration, increased differentiation in the classroom, and additional

staff professional development. However, there were many barriers faced as implementation of RTI required a great deal of additional work and commitment from everyone. Full implementation of RTI school wide requires a huge increase in organization and requires a commitment from all school personnel.

Even though RTI incorporates a system of leveling individual students, based on their abilities, it also focuses on the larger population of students. RTI is often used for classifying students with learning disabilities and can help teachers and parents determine whether a student's failure to progress is the result of inadequate instruction or is due to a potential learning disability (Donovan & Shepard, 2013). For the purposes of the study reported here, greater focus will be on leveling within an individual classroom and using leveling techniques to differentiate lessons. For this reason, the techniques and methods used in RTI are relevant to this study, but on a much smaller scale and dealing with a smaller number of students.

Grouping Based on Ability

While RTI is an effective school-wide strategy for identifying student needs, there is a need for teachers to develop the best methods to meet their students' needs within their individual classrooms. Classrooms are very diverse in terms of academic ability and achievement levels, and the range of abilities and achievement levels is continuously increasing, as are the students' specific educational needs. One frequently used way to organize students is by ability grouping – adapting instruction to the needs of different ability groups within a heterogeneous classroom (Prast et al., 2018).

In the Prast et al. study, teachers were provided with professional development in order to help them implement ability-grouped lessons using a program called GROW.

Through this program, teachers differentiate mathematics lessons using a cycle of differentiation which start with the teachers analyzing students' current skills and dividing them into three groups (low, average and high achieving). In the next part of the cycle, the teacher sets goals for each set of students; then, the teacher differentiates instruction through whole-class, small group and individual instruction. Next, the teacher provides practice tasks that are differentiated for each group and, last, the teacher evaluates the effectiveness of the instruction and reassesses each student's achievement level. To monitor the effectiveness of the program, students were given a standardized mathematics assessment at the middle and end of the school year, over a two-year period. Overall, the results showed that ability grouping in these schools was mildly successful. Students in the low group experienced more increases in success than those in the higher groups. Teachers who were experienced, committed to the program and focused on the specific needs of individual students were essential to the success of the program.

Instructional Planning and Professional Development & Teacher Efficiency

Many teachers struggle to provide students with access to what works best for them because they are unable to differentiate and provide multiple paths and options for students (Dixon, 2014). In order for RTI, differentiation, or leveling to occur, teachers must be both fully committed to the designated program and be properly educated. This requires ongoing support for the teachers and appropriate time that is dedicated to planning and professional development.

In a study by Dixon et al. (2014), the authors found that a greater number of professional development hours is positively associated with teacher efficiency and that teacher efficiency is important to differentiation. Teacher efficiency is a teacher's ability

to properly execute strategies within the classroom to meet the needs of their students. Self-efficiency is a teacher's judgment of his or her own capabilities to bring out desired outcomes in students. The authors studied the relationship between self-efficiency and teacher differentiation as well as between professional development and teacher differentiation. The study followed teachers within two school districts. The teachers were given surveys on self-efficiency and differentiation and then the teachers were observed. Each teacher was then analyzed and given a score for their level of self-efficiency and ability to differentiate. The results from these analyses were then compared to the number of professional development hours done by each teacher. The results showed that greater professional development was positively associated with both a teacher's sense of efficacy and ability to differentiate. Dixon et al. (2014) concluded that teachers who are more self-efficient are more comfortable and confident in their abilities to differentiate which allows them to differentiate more frequently.

Self-Monitoring

In order to differentiate or tier lessons based on ability, students must be grouped accurately and then able to advance amongst tiers. In order to aide in proper advancement amongst tiers, students should understand their individual progress and be able to self-monitor their progress throughout. Students using self-regulated learning strategies set learning goals for themselves and are highly motivated to pursue them (Friedrich et. al., 2013). By understanding their own progress students can communicate with teachers about whether or not they are placed in the proper tier. A study done by Dorrenbacher et. al. (2016) examined the relationship between student's self-regulation strategies and their grade point average. Self-regulation evokes reflection that allows

learners to engage in thoughts, emotions, and actions that support achieving personal goals. The authors of the study administered a survey with questions relating to student motivation in respect to forethought, performance and reflection. Forethought includes goal setting and planning, performance includes self-motivational thoughts and intrinsic motivation and reflection includes evaluating performance and goal achievement. The results showed self-regulated learning strategies varied greatly amongst students, but overall, students with high motivation showed good self-monitored skills and had high achievement.

Screening & Monitoring Student Progress

In order to effectively execute a tiered lesson or curriculum, each student must first be analyzed for their current level of achievement and prerequisite knowledge. This requires an initial assessment to determine where the student should be properly placed. The assessment can be formal or informal but requires that the teachers understand each students needs prior to the lesson. The teachers should focus on pushing students to their highest potential possible. In order to best understand their potential, a teacher must understand each student and their current level (Levy, 2008). In addition, groups are not permanent, learners are evaluated prior to instruction and the groups change to meet each learners needs (Richards & Omdal, 2007).

Janet Herrelko (2013) conducted a study about differentiated lessons using a four-tiered format. In the study, she stresses the importance of being informed about the background knowledge, experience, and learning preferences of students. This enables teachers to select learning techniques, strategies, and environments that engage students in active learning. The study describes various formative assessments that can be used in

order to aide in placement decisions. These include: exit slips from the previous day, conversations with student, prior knowledge questions, quizzes, homework evaluations or written responses at the start of the lesson. The study follows a teacher through two units of curriculum. The first, a non-differentiated standard lesson. The second placed students in one of three tiers based on a pre-assessment. Students were revaluated for correct tier placement at the start of each day. Results showed that 73% of the class performed better when lessons were tiered. In addition, tiering helped the teacher to understand the importance of ongoing assessment. The teacher in the study noted that ongoing assessment helped him to understand student achievement and what their individual needs were for further instruction.

Tiered Lessons

The concept of tiered lessons joins together the ideas of differentiating instruction, meeting the needs of individual students, grouping students based on ability, pre-assessing, continuously monitoring student progress and needs, and self-monitoring, all within an individual classroom environment. A tiered lesson is a differentiation strategy that addresses a particular standard, key concept, and generalization, but allows several pathways for students to arrive at an understanding of these components based on their interests, readiness, or leaning profiles. Pierce and Adams (2004) break down the elements and steps involved in designing a tiered lesson and present examples of how to execute a tiered lesson. In order to properly execute a tiered lesson, a teacher must have complete knowledge of the topic and standards as well as prerequisite knowledge required for the lesson. Equally as important, the teacher needs to have a good understanding of the students' prerequisite knowledge and their current ability levels in

order to adequately design the tiers to meet student needs. The teacher must also have multiple forms of assessment administered throughout the lesson. Monitoring using multiple forms of assessment allows teachers to continue to get to know students better and to understand who will need further instruction and who is ready to go to the next level.

Richards & Omdal (2007) conducted a study in secondary science classes in order to understand the positive effects of tiered instruction on students. The study was conducted with three hundred eighty-eight freshmen who were randomly assigned to fourteen science classes at the beginning of the school year. Seven classes were chosen as treatment classes and seven classes were chosen as control classes. Each of the student's received a pre-assessment at the beginning; for the treatment groups the assessment was used to break students into high, middle or low tiers, the control group received the pre-assessment to allow for data analysis at the end of the study. All teachers used the same materials and lesson plans; the treatment groups received lessons in small groups based on their tier and the control groups all received middle tier instruction. An assessment was then taken at the end of the lessons and results were compared. The study supports curriculum differentiation through tiered assignments as an effective way to increase academic achievement for lower achieving students. The median score of students in the midrange and low-level tiers were better in the treatment group than in the control group. The high background knowledge learners performed equally well in both groups. Students in the higher tiers were not challenged enough, suggesting that this type of instruction may not be best for gifted students.

Summary

Differentiating curriculum and tiering lessons based on student's abilities and readiness ensures students are able work at a level and pace that they are comfortable with. On a large scale, RTI, differentiating and leveling students can be very successful but also very difficult to manage. Differentiating individual lessons or class curriculum using tiers incorporates many of the methods included in RTI but does it on a smaller scale. Tiering lessons is more manageable for individual teachers. It requires a great deal of commitment and professional development from educators, but can be done without the full commitment of the whole school. Using tiered lessons and the essential strategies teachers can better understand their students and can work towards ensuring their individual needs are met.

Chapter Three

Methodology

Setting and Participants

This study took place at a high school in a suburban town in northern New Jersey. According to the school database in January of 2019, there were 1,207 students enrolled in the school, about 82% Caucasian, 8% Latin American, 1.2% African American, 7.5% Asian and about 1.3% that identify with multiple races. According to the most recent NJ School Performance Summary Report, 18% of students have disabilities, 3% are economically disadvantaged, 98% graduate and 87.3% are enrolled in college 16 months after graduation. The typical school day runs for 6 hours and 53 minutes, with classes running for 47-minute periods on Monday, Thursday and Friday and for 87-minute blocks on either Tuesday or Wednesday, for a total of 228 minutes of instruction each week per class.

The study took place in two Algebra II secondary special education classrooms. Each class is taught by a different teacher, both teachers have 7.5 years of experience and are highly qualified in mathematics. Each classroom also has a teacher's aide. Each teacher's aide holds a bachelor's degree but neither is certified in teaching. The aides have been working in the district for 10 and 6 years and have 2 and 6 years of experience in the math classroom, respectively. There is a total of 17 students enrolled between the two classes, 5 females and 12 males. All of the students are juniors and either 16 or 17 years old. 14 of the students identify as Caucasian and 3 of the students identify at Latin American. All of the students in this study have Individualized Education Plans and have diagnosed learning disabilities, 12 students are classified with Specific Learning

Disabilities, 4 as Other Health Impaired and 1 student is diagnosed with Multiple Disabilities including severe anxiety, depression and oppositional defiant disorder. Table 1 displays the student data.

Table 1

Student Data

Student	Gender	Age	Ethnicity	Native Language	Grade	Class Schedule	Classification	MP1 Quiz Average
# 1	F	17	Hispanic	Spanish	11	Resource & Inclusive	SLD	81.57
# 2	M	17	Caucasion	English	11	Resource & Tech School (Mechanics)	SLD	79.79
# 3	F	17	Caucasion	English	11	All Resource	SLD	70.14
# 4	M	16	Caucasion	English	11	Resource & Inclusive	Other health impaired	70.57
# 5	M	17	Caucasion	English	11	All Resource	SLD	70.96
# 6	F	16	Caucasion	English	11	All Resource	Multiple Disabilities: Anxiety, Depression	84.11
# 7	F	17	Caucasion	English	11	Resource & Inclusive	SLD	87.57
# 8	M	17	Caucasion	English	11	All Resource	Other health impaired	74.39
# 9	M	16	Caucasion	English	11	Resource & Tech School (Culinary)	Other health impaired	89.57
# 10	M	17	Caucasion	English	11	All Resource	SLD	79.46
# 11	M	17	Caucasion	English	11	All Resource	SLD	78.07
# 12	M	17	Caucasion	English	11	All Resource	SLD	82.11
# 13	M	17	Caucasion	English	11	All Resource (Attempted moving to inclusive math and then moved back)	SLD	79.43
# 14	F	17	Caucasion	English	11	All Resource	SLD	67.71
# 15	M	16	Hispanic	Spanish	11	All Resource	SLD	85.00
# 16	M	16	Caucasion	English	11	All Resource	SLD	70.86
# 17	M	17	Hispanic	Spanish	11	All Resource	Other Health Impaired	87.25

Most of the students are enrolled in all secondary special education or resource classes with a few of the students being enrolled in the collaborative setting for one or two of their classes. All students are enrolled in general education elective classes and two of the students attend technical school during the second half of the day. Fifteen of the students have been in the secondary special education classroom for mathematics since their freshman year. One student took collaborative geometry as a sophomore and returned to the secondary special education classroom this year. Another student began

the year in the collaborative setting for Algebra II and joined the secondary special education setting in October. Many of the students have difficulty remaining focused, have attendance issues and are regularly absent or late to class.

Procedure

The intervention was implemented during the second semester of the school year, February to April. The curriculum consisted of 3 units: Factoring Polynomials, Quadratics in Vertex Form and Quadratics in Standard Form. Each unit was broken down into three levels respectively. The levels increase in difficulty, with level one being the easiest. Each lesson began with a pre-assessment which assessed each student's beginning knowledge of the topic. Based on their beginning knowledge, students began at level 1 or level 2. Then, students practiced at their respective levels until they were comfortable and felt ready to advance to the next level. Each teacher instructed using the same materials and assessments. Throughout the unit, students received a combination of formal lessons, independent practice and small group practice.

Students were encouraged to move on to the next level after demonstrating consistent ability in their current level. Students were also asked to monitor their own progress and encouraged to communicate their readiness for the next level through informal conversation and interaction with teachers and teachers' aides as well as formal reflections. In order to formally advance to the next level, students were required to complete a "ticket to the next level" which consists of questions that allow the students to demonstrate knowledge of their current level and a readiness to move to the next level. The exit ticket was either on paper or using an online device such as quizizz.com or desmos.com.

Students continued advancing through the levels up until the assessment and were assessed only on the levels which they were instructed on. There were three quizzes for each unit administered throughout the class. Level 1 quizzes contain only level 1 problems, level 2 contain both level 1 and level 2, and level 3 contains all three levels. The students received a grade of 0 – 100% based on their quiz results.

The students' results were compared to their quiz results from three units in the first semester, November to January. The three units were: functions graphically, functions algebraically, and multiplying polynomials. Throughout the first semester, students were instructed and assessed using a traditional format. Students received formal large group lessons as well as independent and group practice. Students advanced through the curriculum as a group. Fifteen of students received the same assessment each time and two students received additionally modified assessments.

Variables

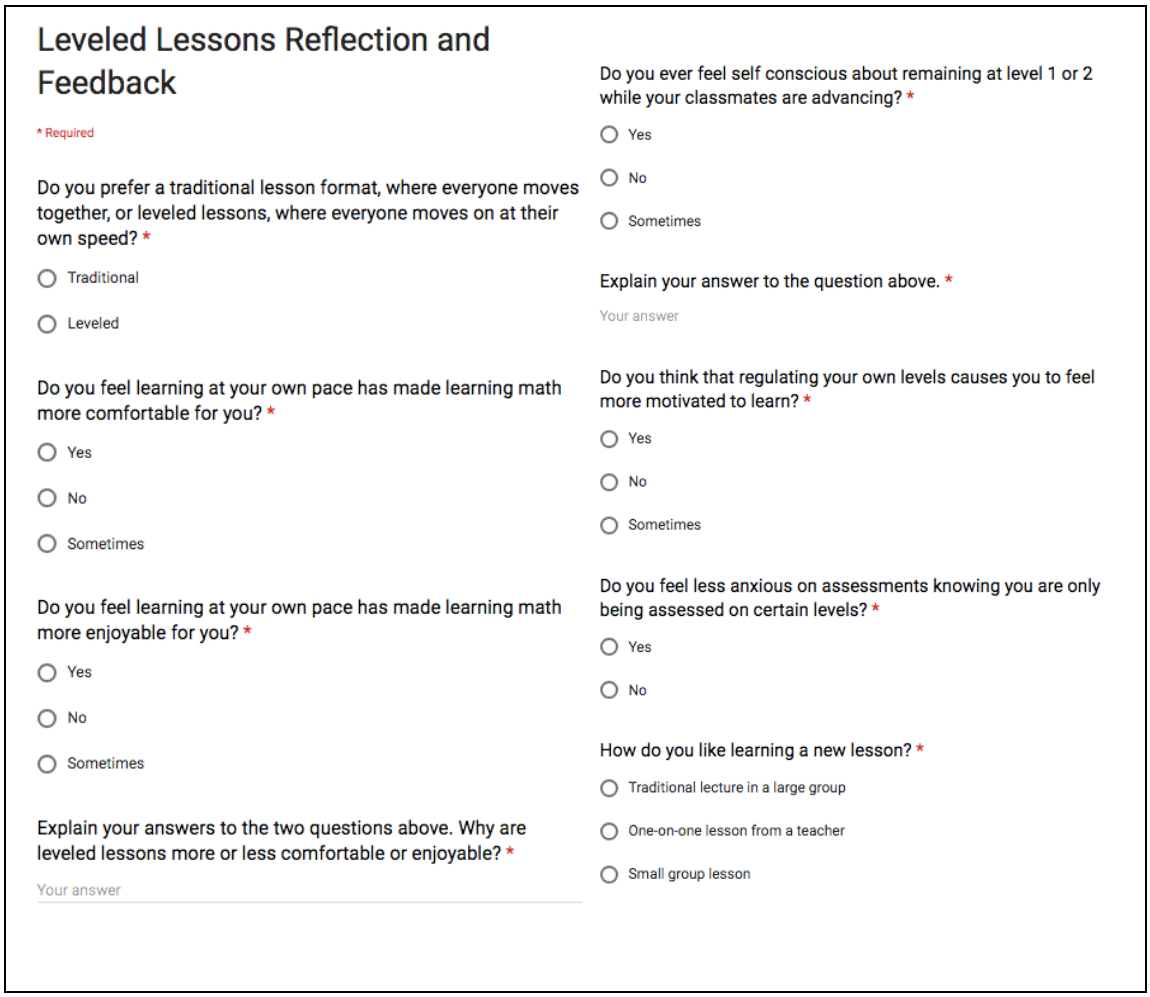
The independent variable in this study is the leveled lessons designed to allow students to advance through the curriculum at a pace that is comfortable for them.

The dependent variable in this study is the students' quiz scores. The assessments were created by the teachers and both classes administered the same quizzes. Teachers created the assessments based on the materials used in class.

Research Design

The study used is a single- subject experimental design with a pre- posttest data analysis approach. The data is quantitative, and the results will be interpreted based on each student's growth. The students' semester 2 quiz grades were compared to their semester 1 quiz average. In addition, the entire class averages will be considered.

Qualitative data will be collected using a survey to consider the students' perceptions of how they felt about the tiered lessons and how they affected their motivation and self-confidence. Figure 1 displays the survey administered to the students through google forms. The data will be carefully analyzed using excel and a matched pair t-test comparing the student's semester 1 and semester 2 quiz averages.



Leveled Lessons Reflection and Feedback

* Required

Do you prefer a traditional lesson format, where everyone moves together, or leveled lessons, where everyone moves on at their own speed? *

- Traditional
- Leveled

Do you feel learning at your own pace has made learning math more comfortable for you? *

- Yes
- No
- Sometimes

Do you feel learning at your own pace has made learning math more enjoyable for you? *

- Yes
- No
- Sometimes

Explain your answers to the two questions above. Why are leveled lessons more or less comfortable or enjoyable? *

Your answer

Do you ever feel self conscious about remaining at level 1 or 2 while your classmates are advancing? *

- Yes
- No
- Sometimes

Explain your answer to the question above. *

Your answer

Do you think that regulating your own levels causes you to feel more motivated to learn? *

- Yes
- No
- Sometimes

Do you feel less anxious on assessments knowing you are only being assessed on certain levels? *

- Yes
- No

How do you like learning a new lesson? *

- Traditional lecture in a large group
- One-on-one lesson from a teacher
- Small group lesson

Figure 1. Student Feedback Survey

Chapter Four

Results

Summary

In this single- subject experimental design, the effects of differentiating instruction using leveled lessons was examined use a pre-posttest strategy. Two Algebra II classes in a high school were instructed and assessed using traditional lesson formatting and then with leveled lessons. The research questions to be answered were:

1. Do multi-tiered lessons, that allow students to advance based on readiness levels, allow high school math students to find more success and more motivation to learn?
2. Does allowing students the ability to self-regulate and advance at their own pace provide for a more enjoyable learning environment?
3. Does allowing students to work at their own readiness level cause less anxiety and more positive feelings towards math?

For the first half of the year, students were instructed traditionally using formal whole group lessons, in addition to independent practice, group, and partner work. For the second half of the year, the students were instructed using tiered lessons. Each unit was broken down into three levels. Students were pre-assessed for which level they should start at and then advanced through the levels. Students were assessed only at the levels in which they were instructed.

Quantitative Results

Table two shows the number of students assessed at each level for each unit in semester two. Students were assessed at the highest level of instruction that they

advanced to. If a student was assessed at level 1, it means they were not exposed to the level two curriculum. For the factoring polynomials unit, about 18% remained at level 1, 71% advanced to level 2 and 12% advanced to level three. In the vertex form unit about 12% remained at level one, 30% advanced to level two and 59% advanced to level three. In the standard for unit about 29% remained at level 1, 65% advanced to level and 6% advanced to level three. Overall, about 20% of students only received level one instruction, 55% of students received level one and level two instruction and 25% of students received instruction on all three levels. Figure two. Displays the percentage of students that were assessed at each level.

Table 2

Semester 2 Levels by Unit

Level	Factoring Polynomials	Vertex Form	Standard Form	Totals
Level 1	3	2	5	10
Level 2	12	5	11	28
Level 3	2	10	1	13
Total	17	17	17	

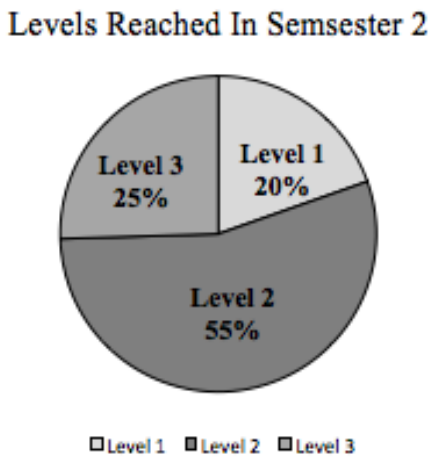


Figure 2. Percentage of Students Assessed at Each Level

During semester one, students collectively advanced through the curriculum and were mostly all given the same assessments. There were modified assessments for two of the students who each received shorter quizzes with less problems. During semester two, students advanced individually and were assessed only at the level of the curriculum they reached. Students were graded traditionally using a 0 – 100% scale. Table 3 displays the quiz results for each student for the three units in each semester, a semester one and semester two quiz average and the whole class average for each assessment and each semester.

Table 3

Quiz Scores for Each Student and Semester 1 and 2 Quiz Averages

Student	Functions Algebraically	Functions Graphically	Multiplying Polynomials	S1 Average	Factoring Polynomials	Vertex Form	Standard Form	S2 Average
1	88	70	88	82	73	85	91	83
2	84	78	84	82	94	91	91	92
3	65	70	65	67	65	91	100	85
4	73	70	65	69	85	85	91	87
5	78	70	70	73	73	85	65	74
6	82	84	88	85	81	100	100	94
7	88	78	88	85	100	100	91	97
8	78	70	78	75	65	65	65	65
9	100	100	100	100	100	95	100	98
10	78	88	78	81	85	91	65	80
11	78	78	78	78	94	94	77	89
12	95	89	88	90	85	82	85	84
13	73	82	95	83	100	100	100	100
14	78	65	50	64	77	89	65	77
15	82	82	78	81	100	100	100	100
16	73	78	70	74	85	94	91	90
17	88	82	88	86	100	96	100	99
Average	81	78	79	80	86	91	87	88

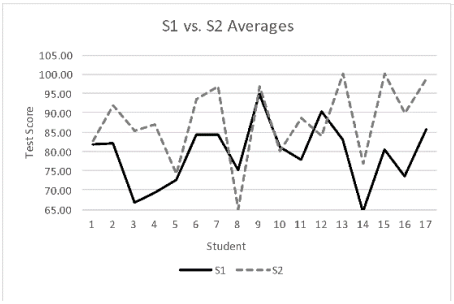
Table 4 displays the semester one and two quiz averages along with the difference between semester one and two (Semester two minus Semester one) as well as the percent change from semester one to semester two. The data is sorted by the highest change in

score to the lowest change in score. Five students increased their scores by over 15 points from semester one to semester two and three students decreased their scores from semester one to semester two. The average increase in quiz points was 8.42 points, which is an 11.13% increase. Figures three and four display a line graph and bar chart of the quiz scores. Most students increased their scores with one student showing a dramatic decrease.

Table 4

Semester 1 & 2 Quiz Averages, Change (S2 – S1) and % Change

Student	S1	S2	Change	% Change
15	80.50	100.00	19.50	24.22
3	66.67	85.26	18.59	27.88
4	69.33	86.92	17.59	25.37
13	83.17	100.00	16.83	20.24
16	73.67	90.00	16.33	22.17
17	85.75	98.75	13.00	15.16
14	64.33	77.02	12.69	19.72
7	84.50	96.92	12.42	14.70
11	78.00	88.51	10.51	13.48
2	82.00	91.92	9.92	12.10
6	84.50	93.58	9.08	10.75
9	95.00	97.00	2.00	2.11
5	72.67	74.23	1.56	2.15
1	81.83	82.82	0.99	1.21
10	81.25	80.26	-0.99	-1.22
12	90.42	83.92	-6.50	-7.19
8	75.33	65.00	-10.33	-13.72
Average	**79.35**	**87.77**	**8.42**	**11.13**



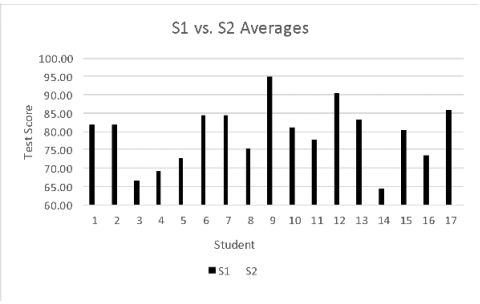


Figure 3. Semester 1 and Semester 2 Quiz Averages (Left)

Figure 4. Semester 1 and Semester 2 Quiz Averages (Right)

A matched paired t-test was performed. The null hypothesis was that there would be no change in the semester one and semester two quiz averages, $H0:\mu=0$. The alternative hypothesis was that the change from semester one to semester two is greater than zero, $Ha: \mu>0$. The results were statistically significant with $t=4.48$ and $p<.0001$. A 95% t-interval revealed results of an interval of 4.6947 to 13.134 for the difference between semester one and semester 2 quiz average.

Qualitative Results

Students were given a survey using google forms to understand how well the leveled lessons were received by students. The students were asked, "Do you prefer a traditional lesson format, where everyone moves together, or leveled lessons, where everyone moves on at their own speed?" Figure five displays results of this question. The results showed that 11 students prefer leveled lessons and six students prefer traditional whole class lessons. The students were also asked, "Do you feel learning at your own pace has made learning math more comfortable for you?" And "Do you feel learning at your own pace has made learning math more enjoyable for you?"

Figures 6 and 7 displays the results. Thirteen of the students said leveled lessons make math more comfortable for them and 11 said the leveled lessons make math more enjoyable for them. They were also asked, "Do you think that regulating your own levels causes you to feel more motivated to learn?" and "Do you feel less anxious on assessments knowing you are only being assessed on certain levels? Figures 8 and 9 display the results. Students were also asked whether they preferred to learn using a lecture, one-on-one or in small groups. Student responses varied: five students each preferred one-on-one or small groups and seven preferred lectures and note taking. Additionally, 12 of the students said they feel less anxious and 11 of the students said they feel more motivated. When students were asked, "Do you feel self-conscious when you remain at a lower level while your classmates are advancing?" Sixteen of the students said they did not feel self-conscious and one said they did.

Students were also asked to explain some of their answers using short responses. They were instructed to explain their answers why leveled lessons more or less comfortable or enjoyable? Some students provided a lot of detailed and others were short and less informative. The following are samples of student responses, taken from the google form they provided their answer on. One student expressed that moving through lessons made him feel proud: "I think leveled lessons are more comfortable because if you work hard on level one and you go on it makes you feel more proud of yourself." Another student responded that levels help to alleviate pressure and helps him to push himself, stating, "it works the best for me because I'm never pressured when I'm working. Also, having leveled lessons motivates me to try my hardest because I'm a competitive person."

One student that does not like leveling said she didn't like being moved because she likes working with her friends. She said it makes her, "less comfortable because then I always get split away from my friends. If we all got taught together, we could help the kids who need help." A student who feels self-conscious by the levels said, "leveled lessons make you feel less confident because everyone goes to a different level and your stuck on level one and you don't feel like you are smart."

The quantitative quiz results helped to understand how leveled lessons affected student performance and an analysis of how many quizzes were taken at each level showed how effective students were at advancing through the levels. The qualitative quiz results helped to understand student motivation and how students' perception of mathematics assessments was affected by the levels.

In conclusion, quantitative data analysis showed that students increased their quiz averages using the leveled lesson format. In addition, students were motivated to learn and advanced to level 2 or 3 despite being given an option to remain at level 1. Qualitative data analysis showed most students preferred the leveled format and increased their comfort and reduced their anxiety on assessments.

Figure 5. Leveled vs. Traditional Lesson Preference

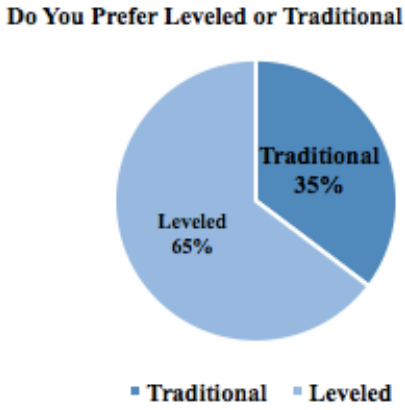


Figure 6. Does Leveling Make Math More Enjoyable?

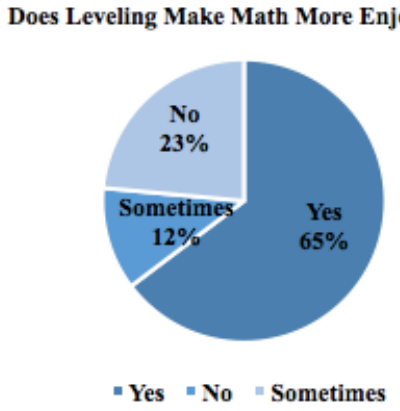


Figure 7. Does Self.-Regulating Increase Motivation?

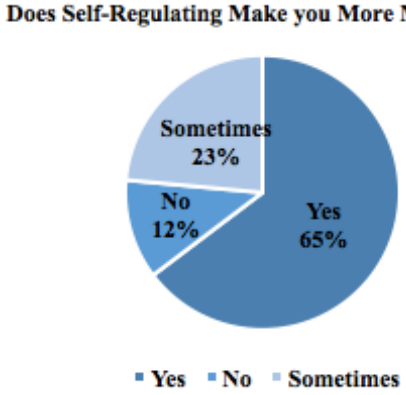


Figure 8. Does Leveling Increase Comfort?

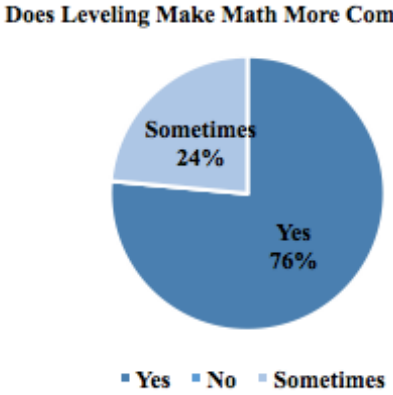


Figure 9. Does Leveling Decrease Anxiousness?

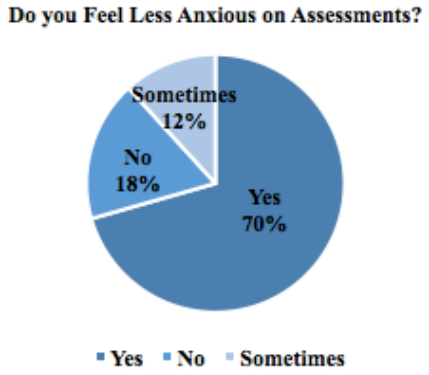
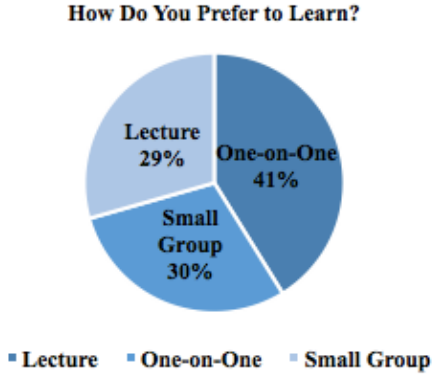


Figure 10. Student Learning Preferences



Chapter Five

Discussion

Review

This study examined the effects of teaching high school mathematics students using leveled lessons. The participants of this study were 17 students from a high school in North Jersey. The students were all in eleventh grade and classified as having specific learning disabilities. Furthermore, the majority of these students were in all resource classes for their major academic subjects and inclusive classes for electives. The students were chosen based on their enrollment in one of the two secondary special Algebra 2 classes used for this study. Each class was taught by a different teacher, each with the same amount of teaching experience. The students were instructed and assessed traditionally throughout the first semester. In the second semester, students were instructed using a leveled lesson format. All students were pre-assessed on each topic and then placed into a level based on their current knowledge. They then advanced through the levels within each unit by demonstrating knowledge of the previous level. Students advanced at their own individual pace and were only assessed on the levels that they received instruction on. There were three quizzes administered each time: level 1, level 2 and level 3. In the first semester, most students received the same assessment and two students received modified assessments.

This study posed three questions about the effectiveness of leveled lessons. First: Do multi-tiered lessons, that allow students to advance based on readiness levels, allow high school math students to find more success and motivation to learn? To answer this question, the average of three quiz scores from the first semester were compared to the

average of three quiz scores from the second semester. The study showed that the intervention was successful as 14 of the 17 students improved their quiz scores, and 9 students improved their scores by over 10 points. A matched paired t-test before and after comparison was also done, revealing a $t=4.48$ and a $p<.0001$, showing strong statistical evidence that the semester 2 quiz averages were greater than semester 1 thus supporting the efficiency of the leveled lessons. A 95% t-interval was also done for the difference in quiz scores revealing an interval of 4.69 to 13.13. This showed 95% confidence the true mean difference between the semester 1 and semester 2 quiz averages is between 4.6947 points and 13.134. The study supports leveled lessons as an effective intervention method to increase student's math success.

In order to understand how the students' motivation to learn was affected, the number of students that were able to advance past level one for each of the three lessons was analyzed. Three of 17 students remained at level 1 in the first unit, 2 in the second unit and 5 in the third. Combining the units, there were 51 observations and 3 quizzes each for 17 students. Of the 51 quizzes, 20% were level 1, 55% level 2 and 25% level 3. This showed that, despite being given the option to do the minimum amount of work and remain at level 1, 80% of the students were motivated to push past level 1 and work to their higher potential. It is unclear whether the 20% that remained at level 1 were unmotivated or if level 1 was, in fact, their highest potential. In addition, students were asked in a survey whether or not leveled lessons made them feel more motivated to learn. Eleven of the students said they felt more motivated to learn, four reported they sometimes felt more motivated to learn, and two reported that levels did not help their motivation.

The second question asked: Does allowing students the ability to self-regulate and advance at their own pace provide for a more enjoyable learning environment? And, does allowing students to work at their own readiness level cause less anxiety and more positive feelings towards math? To address their perceptions of the leveled lessons, students were administered a survey. Overall, students received the leveled lessons with a positive attitude. Sixty-five percent of students reported preferring leveled lessons to traditional and 65% also said that leveled lessons made math more enjoyable for them. In addition, 76% of students reported feeling more comfortable learning math with leveled lessons and 70% reported that they felt less anxious on assessments knowing that they were only being assessed on the material they were given the opportunity to learn, practice and understand. Overall, the survey supports leveled lessons as a way to improve student attitudes and reduce student anxiety towards math.

Limitations

The results of this study were positive; however, there were limitations to the study. One limitation was the number of participants. This study only provided data on 17 students. The study would have been more reliable if there had been more students studied. In addition, the students were all special education students in mainly resource level classes, which reveals the results were successful only within this population.

Another limitation is the setting. This study was conducted in a small setting classroom with a classroom aide which allowed for two adults with less than ten students in each classroom. This environment is extremely conducive for leveling as it allows for many one-on-one and small group lessons. In addition, a small number of students allows for the teacher to have the time and energy to monitor each individual student's

level progress as well as assign and grade multiple versions of an assessment. This lesson formatting was successful within this environment; however, such formatting may be more difficult to implement in a larger classroom setting.

Another limitation is the time available for the intervention. The students were instructed using traditional lessons for a full semester and using leveled lessons for a full semester. However, for this study, only three months of the intervention was analyzed which was compared to three months of the pre-intervention. It would have been more efficient to compare results from a full year without intervention to a full year with intervention.

Another limitation of the results is that most of the data was based on a qualitative opinion-based survey. Students were not asked to reveal their name, were instructed to be open and honest, and their answers would have no effect on their grades or teacher's perception. However, they were administered the survey by their teacher, with whom they have a relationship and may have given answers that were biased to what they think the teachers wanted.

Last, a limitation is the difference in material being assessed. The first semester contained three topics: functions algebraically, functions graphically and multiplying polynomials. The second semester also contained three topics: factoring polynomials, quadratics in vertex form and quadratics in standard form. The topics were all algebra 2 topics and the curriculum were designed to have consistent difficulty as best as possible. However, some topics are naturally more difficult for students and this may have had mild effects on the results.

Practical Implications

In this study, students were frequently checked in with, using formal and informal checks for progress, which allowed them to show their readiness to advance to the next level. Regardless of the use of leveling, students should be monitored for progress frequently, both formally and informally. Formal check-ins are short, graded assignments which show students' progress within each topic. Informal check-ins are consultations with students about their individual progress. Students should be consulted frequently for how they felt they were progressing. It is important for students to take responsibility for their own learning and have an understanding of their own progress and potential. Frequent check-ins also allow for teachers to get to know their students and fully understand their needs and potential for growth. The check-ins are an important part) of student success.

Students were given frequent small group and one-on-one lessons based on their abilities. In large group settings, one-on-one lessons may be less frequent; however, grouping students based on their abilities can allow teachers to break students into small groups and work with each group for a small amount of time. This allows students to get individual attention as well as work at a level and pace they are most comfortable with. Teachers should be sure to understand and address each student's individual needs and growth throughout the school year.

In the second semester, students were given assessments based on their level of the curriculum that they were able to reach. Students performed better given modified assessments. Even if a teacher is not instructing using a level lesson format, they should still administer modified assessments based on students' needs. Every student learns at a

different pace and has different abilities. In this study, giving students modified assessments to meet their own individual expectations allowed them more opportunity for success and caused less anxiety on assessments.

Future Studies

There are large amounts of research on the effects of tiered intervention for reading instruction as well as large scale tiered intervention for whole schools. There is less research on the effectiveness of tiered intervention strategies within single classrooms. This study focused on leveled intervention techniques within two small setting, secondary, special education math classroom. Future studies can focus on larger classrooms including collaborative special education classes. This would still be practical given two teachers in the classroom to help monitor student levels as well as format curriculum and assessments. In addition, future studies could focus on small scale leveled interventions in other subjects, both in small setting special education classrooms and inclusive classrooms.

Conclusion

In this study, three questions were to be answered. First: Do multi-tiered lessons, that allow students to advance based on readiness levels, allow high school math students to find more success and motivation to learn? Fourteen students improved their quiz scores after the intervention, 5 students improved their scores by over 15 points, and 11 students improved their scores by over 9 points. Eleven of the students improved their scores by over 10%. There was an average of an 8.42-point increase and an 11.13% increase from semester 1 quiz scores to semester 2. Student's expressed they like working at their own pace and having control of their own learning. Student's also

expressed feeling confident and proud of themselves when they were able to advance. Next: Does allowing students the ability to self-regulate and advance at their own pace provide for a more enjoyable learning environment? Sixty-five percent of the students reported that leveling made math more enjoyable. Students expressed they enjoyed not having to wait for other classmates to be ready to move on in order for them to. Finally: Does allowing students to work at their own readiness level cause less anxiety and more positive feelings towards math? Seventy percent of students expressed leveled assessments made them feel less anxious and 70% expressed that they felt more comfortable learning math. Students expressed that they feel comfortable learning at their own pace and not self-conscious because they understand everyone learns differently and at different speeds. Sixteen of the students expressed that they were not self-conscious or concerned about what level their classmates were on and were comfortable moving at the pace that was best for them regardless of their peers. In conclusion leveled lessons was shown to be an effective intervention to: improve student success, increase motivation, reduce anxiety on assessments and create overall positive feelings towards math.

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