THE BEST METHOD FOR TEACHING HIGH SCHOOL MATH: INQUIRY-BASED VS DIRECT TEACHING

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Abstract

The Best Method for Teaching High School Math: Inquiry-Based vs Direct Teaching

How should teachers be teaching math in High Schools? This has been a question with much debate over the last decade. Many teachers have focused on the idea of a more traditional approach of lecture and practice called direct teaching, whereas several teachers think that the students need to be doing more problem solving and learn the concepts with their peers by using an inquiry based approach.

This research examined a test group of two different classes in a Washington State High School. Two classes with approximately the same level of achievement were examined. Lessons were taught using both inquiry-based and direct teaching methods and the results of exit slip questions were analyzed for correct answers. The research found that students achieved higher scores on the exit slips when they were taught using a direct teaching method than with the inquiry based method.

The results imply that direct teaching produces higher test scores, but is this our goal in education? Although the direct teaching method is better for understanding, students still should be taught occasionally using inquiry-based approach to improve their problem solving skills, a skill needed in their everyday lives.

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Introduction

Jessica is a junior at Forest Grove High School. Her favorite period of the day is her 4th period Pre-Calculus class. Before this class, she always thought she was bad at math. She remembers zoning out when her teachers used to give rules and tables that she had to memorize. Now, she finds math fun and exciting. She loves that the problems they solve in class are group problems. She is able to figure out the concepts with her group members instead of listening to lectures by the teacher. She feels like she is seeing the big picture idea of mathematics and learning different ways of solving problems. She loves the inquiry-based method of teaching

Joshua is also a junior, though at Glacier High School. His 6th period class is Pre-Calculus, and he dreads it every day. He is expected to solve math problems without the teacher's help, and he usually finds himself lost and confused. Instead of actually learning the math concepts, he feels like the class just wants him to work with his group members and doesn't actually show him how to solve it. He feels like the teacher jumps around, and he is failing to make the connections between the application problems and the math he is supposed to be learning. He fondly remembers those days when the teacher would actually teach him how to do a problem step-by-step. He hates the inquiry-based method of teaching.

In 1989, the National Council of Teachers of Mathematics (NCTM) developed the *Curriculum and Evaluation Standards for School Mathematics* which emphasized a conceptual understanding and problem solving approach to mathematics instead

of the previous direct instruction of facts and algorithms (NCTM, 1989, 1991, 1995; National Research Council, 1989). This shift in methodology produced much debate among teachers and parents in the math community. This controversy become so impactful that it was coined "Math Wars" by commentators John A. Van de Walle and David Klein (Schoefeld, 2004, p. 254).

The question at the core of this debate is: How do students' best learn math? Is an inquiry based approach best for students, or are the traditional, direct teaching methods ideal? There is a great deal of research on both sides of the debate. As a high school math teacher, I have taught using both methods and as the story of Jessica and Joshua explains, each student learns math differently. I like different aspects of both approaches. In an inquiry-based approach, I like that the responsibility for learning is placed on the students. They are able to explore different options to solve problems. In a direct teaching model, I like the clarity and structure that epitomizes this approach. I hypothesize that at a higher level of mathematics, a direct or traditional method of teaching may be more effective because of the difficulty in the content. The literature suggests that both methods of teaching have shown to be effective, but the question remains: Which is the best method?

Literature Review

In order to determine which method of teaching is the best for mathematics it is important to study the research that has already been undertaken. There is a significant amount of literature that discusses how the shift from a direct teaching to

inquiry-based methodology first began. There is also a significant amount of research that favors both methods of instruction, including teacher opinion of each method. In this literature review I will discuss the shift in math standards from skills-based to problem solving cooperative based, the method and effectiveness of direct instruction, and the methods and effectiveness of inquiry based teaching.

The Shift Toward Problem Solving

Throughout the last decade many groups have been debating what math content should be taught in schools and how it should be taught. In 2006, National Council of Teachers of Mathematics released "Curriculum Focal Points". This document was a list of content standards that each grade ought to master before moving on to the next grade. In 2009 the group released a follow-up to "Focal Points" called "Focus in High School Mathematics: Reasoning and Sense Making". In this document the NCTM explained that the focal points and standards that had previously been released were simply not enough. In addition to the content standards, students also need to be able to apply problem solving techniques to different situations. This type of skill is something that the students will need daily in their future jobs (Cavanagh 2009).

Reaction to the document was mixed. Some teachers thought that this was an exciting shift in the focus of teaching high school mathematics while others were concerned that this was a weak approach to teaching mathematics and the standards were not very content rich (Cavanagh, 2009). Other researchers have noted that in mathematics, meaningful learning includes making sense of the work,

problem solving and decision making (Douglas, Burton, Reese-Durham 2008, p.184). This is not something that is taught when students are simply memorizing formulas and for many teachers, this document voiced the concern that they had been feeling for quite some time: Students need to learn how to problem solve.

The change of the standards in mathematics is not a random inexplicable event. The shift comes with the change in our technology and the requirements of the job market. Machines can do equations and the rote memorization for us, but the thinking and problem solving is the hardest part (Marshall 2003, p.194). So, as these jobs are shifting, the students need to be an asset to the workforce. If machines and computers can perform the trivial tasks, then our students need to bring something more to the table. According to the NCTM, this "something" is problem solving, applying mathematics to a variety of situations and being able to solve these problems in many different ways (Martin, et al., 2009).

Direct Instruction Approach

Since the content in High School math classes seem to be changing, it would only make sense that the methodology may also need to follow this change. The direct instruction approach to teaching has been one of the most commonly used methods in teaching mathematics. Direct instruction is a scripted method of teaching that is fast-paced and provides constant interaction between students and teachers and contains a vast amount of drill and content (Douglas et al., 2008, p.184). Direct instruction has also been defined as an instructional sequence that

includes demonstration, controlled practice with prompts and feedback, then independent practice with feedback (Din, 1998, p.10).

In 1998, Feng Din conducted a research study in which students between the ages of 6-17 were involved in a summer school focused on mathematics. These students were asked to take the program because they were anywhere from 3-5 grade levels below where they were supposed to be in math. In this summer school, the teachers used a direct instruction approach to teaching. Throughout the teaching process teachers were told to review, clarify, repeat instruction, drill and practice while continuing to monitor student progress. In addition, each student had an individualized learning plan prepared by the teacher. The teacher addressed the skills that a specific student was deficient in and developed lessons presented using direct instruction to address these deficiencies. These plans were reviewed by the project director before they were actually implemented. The student received four hours of treatment (teaching) per week. In just a five week period, there was significant growth seen in the student's attitude toward mathematics, systems of measurement, scientific method and basic math skills. The students significantly increased their skills by an average of two Grade Equivalent levels. According to Din, "These finding suggest that the integrated direct instruction approach, when used appropriately, can be both effective and efficient in helping students improve their math basic skills" (1998, p.12).

Another research study was done in 1995 by Kitz and Nash. This was a 10 year research project on college level dyslexia students. They found that direct

instruction and a structured curriculum was the most effective method of increasing their basic algebra skills (Din, 1998, p.6).

Direct instruction has also been used to teach middle school low achieving migrant students who were 2 to 4 years behind where they were supposed to be. A 19-day curriculum consisting of 80 to 95 hours of direct instruction was implemented with this group of students. The pre- and post-test results showed student growth in all four areas: attitudes toward math and science, metric system skills, observation skills and scientific method skills (Din, 1998, p.5).

According to an additional study on students with Emotional/Behavioral Disorders students were taught using direct teaching and computer based teaching. The results in this study found that the direct teaching method was more effective for students with above-average IQ than for participants with lower cognitive levels (Billingsley, Scheuermann, & Webb, 2009).

Inquiry-Based Approach

Despite these positive reports of using direct instruction, there are still many who argue against this method of teaching. Many argue that an inquiry-based method of solving problems is the best way to teach mathematics. Inquiry-based instruction can be defined as "a student centered pedagogy that uses purposeful, extended investigations set in the context of real problems as a means for increasing teachers' insight into student thought process" (Marshall 2009, p.5). Others have described inquiry-based instruction as a process that allows students to choose and apply problem solving techniques (Cavanagh 2009, p.3).

One elementary school in Cedar Lake, Indiana uses an inquiry-based method of teaching. They will write a problem on the board for the students to solve. Then the students split up into either partners or groups and attempt different methods of solving the problem. At the end of the class the teacher will ask the partners or groups to share their methods of solving the problem. (Chapko & Buchko 2004, p.32). The teachers at this school chose to change to an inquiry-based approach from a traditional direct instruction because they noticed that their students were scoring significantly below level of problem solving and math computation on standardized tests. This was a hard transition for these teachers to make because they had never seen an inquiry-based approach of teaching. One teacher, Chapko recalls her own math teacher, "who timed the class as we frantically wrote out math facts on the chalk-board, with the winner getting a coveted candy bar" (2004, p.34). In order to make this transition, the teachers took a two week summer course to be trained in how to effectively teach using an inquiry-based approach. After teaching using an inquiry based approach, they noticed a shift in the attitude of their students toward learning mathematics and have also noticed students are eager to solve problems and investigate different approaches. The teachers at this school have noticed such a difference in the inquiry-based teaching of mathematics that they requested a waiver from the traditional math texts used by the district to an inquiry-based program developed by the University of Chicago.

Inquiry based teaching not only tests what students know, it presses students to put what they know to the tests. Inquiry based teaching involves some

sort of cooperative learning. This means that the students not only learn the math involved, but they learn how to work with their peers in order o solve problems (Stonewater 2005).

O'Donnell argues that inquiry based teaching can create an anxiety free classroom as well as being an effective method of teaching. When students understand that they are able to find their own method of solving a problem, they have less pressure to perform. They find an approach or method that they understand. No longer are they confused or worried that that they won't be able to follow the teacher's explanation. It makes the learner take ownership of his or her own learning (2009).

Douglas, Burton and Resse-Durham point out that a direct instruction provides a good review of previously taught lessons, but is not as effective when teaching new content (2008, p.184). Inquiry based instruction, allows students to make sense of the world around them by applying what they learn to new situations (O'Donnell, 2009). Many teachers have noted that memorization of skills does not provide students with the understanding that they need. It is only when students are able to explore a problem on their own that the learning becomes more real and makes sense to them (Chapko & Buchko, 2004).

The findings are, however mixed. A study sponsored by Educational Testing Services (ETS) piloted a new inquiry based curriculum for mathematics called "Out of the Box". This curriculum included real world scenarios, discovery approach to problem solving and partner/group investigations. The curriculum was implemented

in 3rd, 4th, and 5th grade classrooms and found minimal difference in post test scores. The control group and the inquiry based group had nearly identical scores on the post test.

Teachers also have mixed feelings about inquiry based instruction. In a research study in 2005, a group of pre-service teachers attended a college math class in which they were actually taught using inquiry based instruction. Before and after they took this class they were asked to explain some of the qualities of "the best math class". After they took this inquiry based class, they added many more characteristics describing how important understanding and application was in a math class (Stonewater).

When High School science and math teachers were surveyed about how much they think inquiry based instruction is used and how often it ideally should be used. The math teachers said that they used inquiry based instruction 38.7% of the time, and they thought that it should be used about 57.3% of the time (Marshall, Horton, Igo, Switzer, 2009).

So, if teachers agree that an inquiry based approach to learning should be used, then why are teachers not actually using it? Some theories are that math teachers lack the pedagogical knowledge to implement this style of teaching. This is not something that is from the textbook or a worksheet that they can print out, it is much harder to plan. Teachers also don't have support structures in place for such a method. There are very few professional development opportunities dedicated to math inquiry-based instruction. Time is also a consideration. To plan a lesson using

inquiry teaching takes time and research to come up with valid exploratory questions. Additionally, in high school, instruction at times is geared toward test preparation. And a traditional method of teaching is the most efficient to teach students how to solve the types of problems that will be on these multiple choice, standardized tests (Marshall, Horton, Igo, Switzer, 2009).

Some opinion of the controversy is that the students are at the heart of the matter. According to the article, "Going Beyond Math Wars" special education teachers have felt as if they are being told to teach a certain way (inquiry-based), but it is not the right method for their students. In their experience, when students with disabilities are faced with multistep problems and complex situations students often show lack of persistence and low self-confidence (Cole, 2010 p.2)

In looking at the research, I found that the shift from direct teaching to inquiry-based methods was a direct cause of the NCTM's document "Curriculum Focal Points". The inquiry-based approach aligns with this document because it addresses the problem solving and critical thinking standard. Research shows that inquiry-based learning does work, but it can be difficult for teachers to find the time to come up with the curriculum and the students may not be able to discover the material on their own. Direct teaching has also been shown to be effective, but it may lack the problem solving skills that the students need.

Research Question

With so much mixed research concerning inquiry and direct teaching methods, it is hard for a new math teacher to know which method to use in his or

her classroom. Some research indicates that inquiry-based teaching allows students to think out of the box and learn how to solve problems. Other research indicates that a structured approach of teaching where repetition and practice is included is the most effective. So who is right? Which method of instruction is really the best for teaching High School mathematics? In light of this review of the literature, I am led to the following research question: Is direct instruction or inquiry-based instruction the most effective method for teaching High School math? Does the level of content make one method of teaching more effective than another? Are there different situations where direct instruction would be better than inquiry-based teaching or where inquiry-based instruction would be better?

Methodology

Method and Rationale

This project employed a quantitative methodology. According to Hendricks, "Qualitative researchers attempt to draw random samples of individuals to be studied, which then allows them to generalize results to the larger population from which the sample was drawn" (2009, p.2). A quantitative approach was the most appropriate for this study because I analyzed results from students (who were randomly placed in my Advanced Algebra classes at the beginning of the year) and made a generalization for all High School math classes. There was a control group (direct teaching group) and a response group (inquiry-based teaching group) which were then interchanged. I analyzed exit slips at the end of lessons by comparing the scores between classes.

Sample

The sample for this study was my 1st and 6th period Advanced Algebra classes at a High School in the Pacific Northwest. I purposefully chose these two classes because they had very similar GPA's for 1st quarter this year, and their test score averages are usually very close to the same. My 1st period class has 25 students with three 9th graders, twelve 10th graders, nine 11th graders and one 12th grader. My 6th period class has 30 students with no 9th graders, thirteen 10th graders, thirteen 11th graders, and four seniors. These classes include both male and female classes and it is a required class for graduation, not an elective course.

Instrumentation

For this study, I conducted an experiment in which I taught both of my classes the same material, by using two different methods. I used a direct teaching approach to teach my 1st period class a lesson, then I taught the same lesson to my 6th period class using an inquiry-based approach. Then after a few weeks, I switched the control and response group. I then taught using inquiry-based approach in 1st period and a direct teaching approach to 6th period for a new lesson. I first needed to choose the topic that I would teach and create lesson plans that were both inquiry-based and direct teaching based. For the inquiry based lessons I needed to think of questions that the students would be able to explore with their group members. For the direct teaching method I prepared notes that I gave for each lesson.

I decided to use the topic of rational functions for my first lesson. The reason that I chose this lesson is that the information was similar to something that the students were already familiar with. I figured that the topic would be easy enough that it could be taught with an inquiry based approach as well as a direct teaching approach.

For the inquiry based group, I created a worksheet where the students worked through problems with their group members. I introduced the topic by having them use a graphical approach. I then introduced problems where they would shift the graphs. This is a topic that the students already were familiar with. As the students were working through the worksheet with their group members, I was also monitoring the class by walking around to see how each group was doing.

For the direct teaching group, I made a worksheet of notes that I went through with the class. As we went through the notes together, the students were asked to try problems on their own, and then we would go through problems together and I would correct any misconceptions. I was able to explain the material since I was lecturing in this direct teaching approach.

After I taught each of the lessons I had the students complete "Exit Slips" to determine if they were able to understand the material at the end of that day. These "Exit Slips" were the same in each class. I first asked the students to solve a couple of problems using what they learned in the lesson that day. In addition I asked the students the degree to which they felt that they understood the material on a scale of 1 to 5. I chose only to use these exit slips instead of the results of

quizzes or tests because I wanted to know what the students understood after one lesson. I didn't want them to go home and get extra clarification or have a tutor help them. I wanted them to be tested over strictly what they learned that day in class.

This process was repeated about a month later, but the inquiry-based group and direct teaching group were switched. This time I taught a lesson on absolute value inequalities. In first period, I developed a group/inquiry based lesson in which the class went through the problems with their group members. The problem was introduced both graphically and algebraically. In 6^{th} period, I went through a series of notes with the class and used a direct teaching approach. This topic was a little bit more difficult than the first lesson on rational functions. Exit slips were again given to each class to see how much information they understood from that specific lesson.

This collection system provided anonymity since I am did not use names in my results, but just classes as a whole. No specific students were mentioned, and the classes were still be taught by me, just using a different method of teaching. I have used both methods of teaching in the past, so this is not an extreme adjustment from my own teaching methods.

Analysis and Validity

Once the exit slips were collected for each lesson, I graded them out of a score of 8 points. I also tallied the results of the degree to which the students felt the understood the material. I included these results for each lesson in a scatter

plot graph. I also combined the graphs together so that it would be easier to compare the inquiry based and direct teaching methods for each lesson. I also included the average score for each lesson.

I did bring a little bias to this experiment. My bias is that I am most comfortable using the direct teaching method since this is the method that I use more often in teaching my classes. To guard against this bias, I practiced teaching inquiry based lessons to my other classes so that I would be more comfortable using this method.

Data

The following data shows the results of the exit slips for each lesson as well as the self assessed level of understanding. The first four tables are all for the first lesson on rational functions. First, I broke down the results into the inquiry and direct teaching results of the exit slips. To make each lesson comparable I made the exit slips both out of a score of 8 points. Tables 1 and 5 show the results of both direct teaching exit slips and Table 2 and 6 show the results of both inquiry-based exit slips results. Table 3 and 6 show the combined results of direct and inquiry-based exit slips results for each lesson. Table 4 and 7 show the results of the level of the students understanding. This was taken from the exit slips. Students were to rate themselves on their level of understanding of the lesson. A score of 5 meant that the students felt they completely understood the material and a score of 1 meant that the students did not understand the material.

Table 1
Lesson #1: Rational Functions Lesson
Exit Slip Results for Direct Teaching (1st Period)

# of students	Direct Teaching: Rational Functions Lesson 1st Period								
									(10)
10									x
9									X
8									X
7									X
6							(5)	(5)	X
5							X	X	X
4							X	X	X
3							X	X	X
2					(1)		X	X	X
1					x		X	X	X
	0	1	2	3	4	5	6	7	8
	Score (out of 8 points) **Average Score: 7.05 or 88.125%**								

Table 2
Lesson #1: Rational Functions Lesson
Exit Slip Results for Inquiry-Based Teaching (6th Period)

# of students	Inquiry Based Teaching: Rational Functions Lesson 6th Period								
10									(9)
9									X
8									X
7									X
6							(5)		X
5							X		X
4							X	(3)	X
3					(3)		X	X	X
2	(1)	(1)		(1)	x		X	X	X
1	x	x	(0)	x	x	(0)	X	X	X
	0	1	2	3	4	5	6	7	8
	Score (out of 8 points) **Average Score: 6.04 or 75.56%**								

Table 3
Lesson #1: Rational Functions Lesson
Combined Exit Slip Results

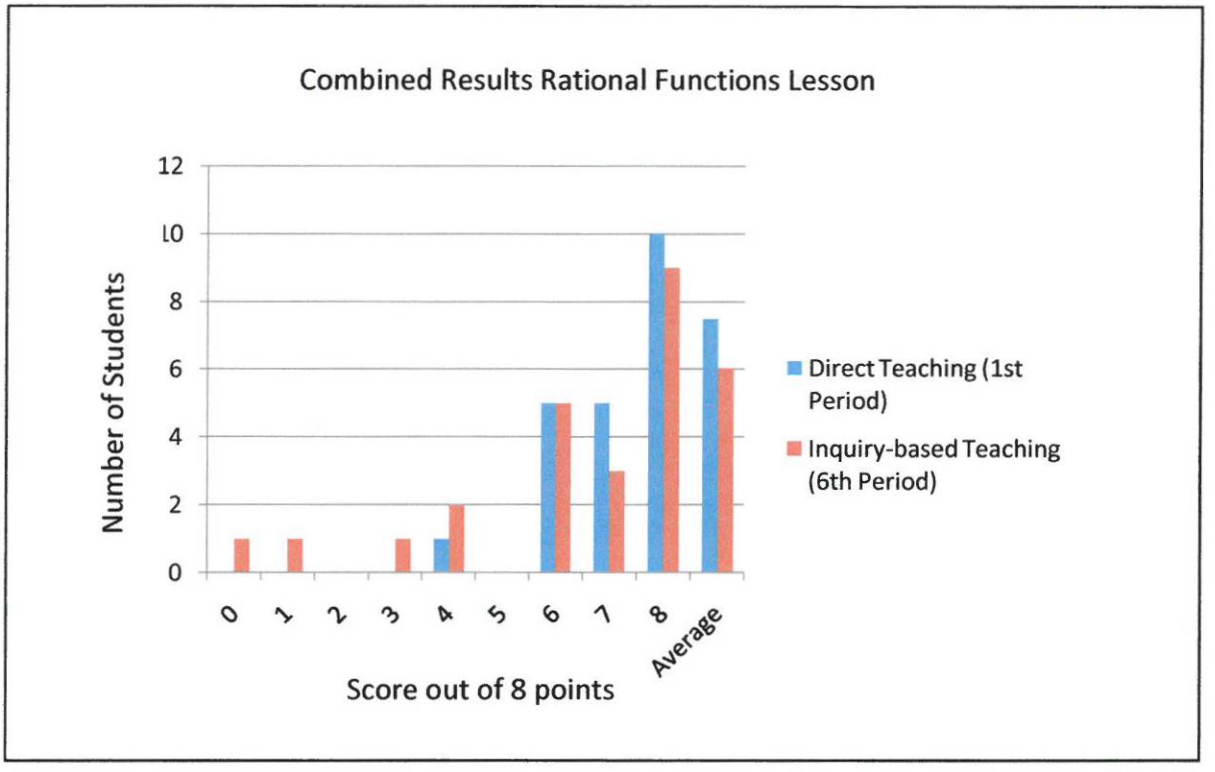


Table 4
Lesson #1: Rational Functions Lesson
Level of Understanding Results (1 to 5)

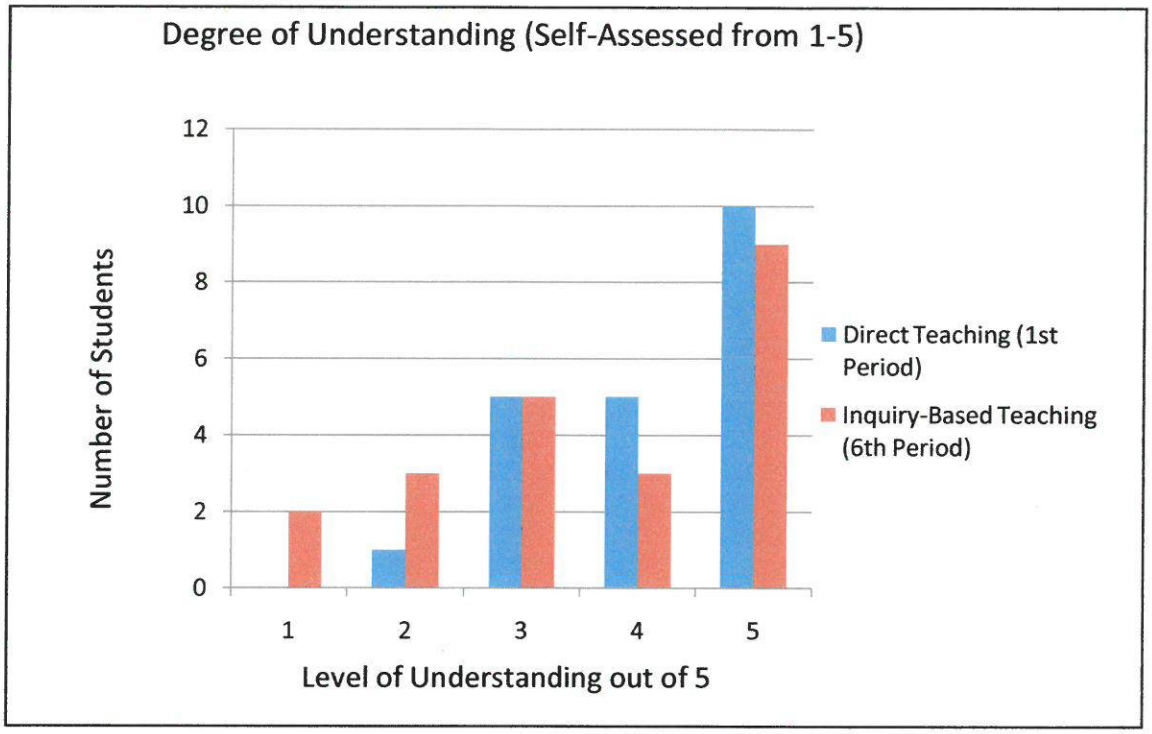


Table 5
Lesson #2: Absolute Value Inequalities
Direct Teaching Exit Slip Results (6th Period)

# of studets	Direct Teaching: Absolute Value Lesson 6th Period								
								(13)	
13								X	
12								X	
11								X	
10								X	
9								X	
8								X	
7							(6)	x	
6						(5)	X	X	
5						X	X	X	
4						X	X	X	(3)
3						X	X	X	X
2						X	X	X	X
1	(0)	(0)	(0)	(0)	(0)	X	X	X	X
	0	1	2	3	4	5	6	7	8
	Score (out of 8 points) **Average Score: 6.5185 or 81.48%**								

Table 6
Lesson #2: Absolute Value Inequalities
Inquiry Based Exit Slip Results (1st Period)

# of students	Inquiry Based Teaching: Absolute Value Lesson 1st Period								
10									
9									
8									
7							(6)		
6							X		
5					(4)		X		
4			(3)		X		X		
3		(2)	X	(2)	X	(2)	X		(2)
2		X	X	X	X	X	X	(1)	X
1	(0)	x	X	x	x	X	X	X	X
	0	1	2	3	4	5	6	7	8
	Score (out of 8 points) **Average Score: 4.5 or 56.25%**								

Table 7
Lesson #2: Absolute Value Inequalities
Combined Exit Slip Results

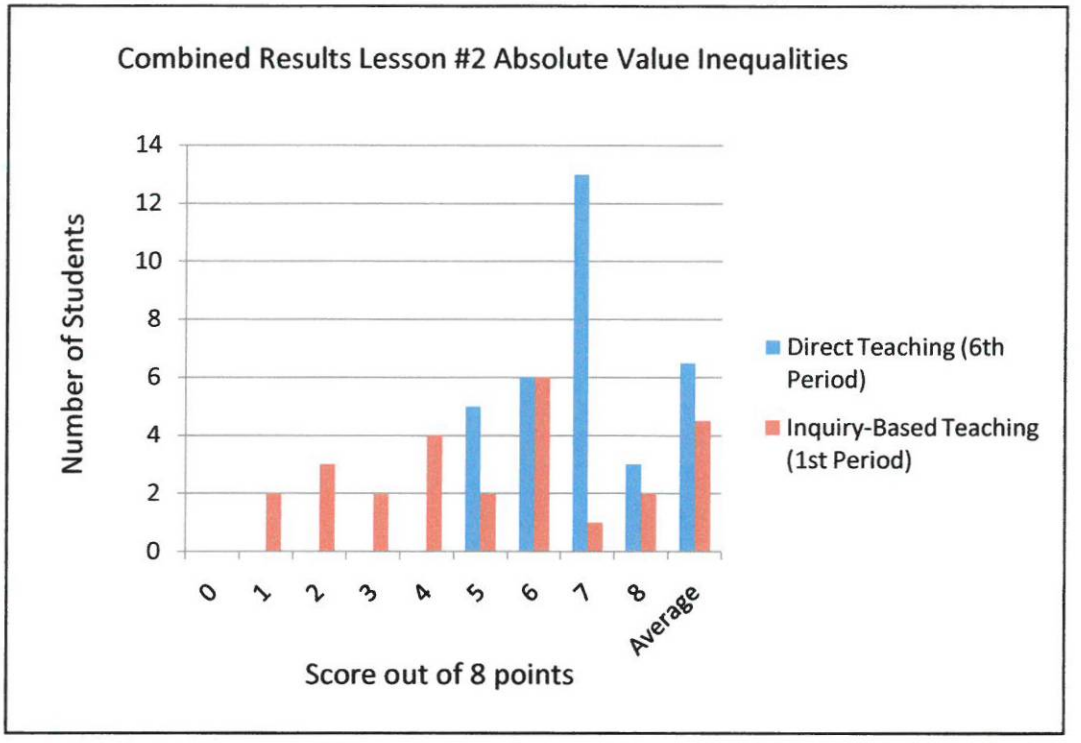
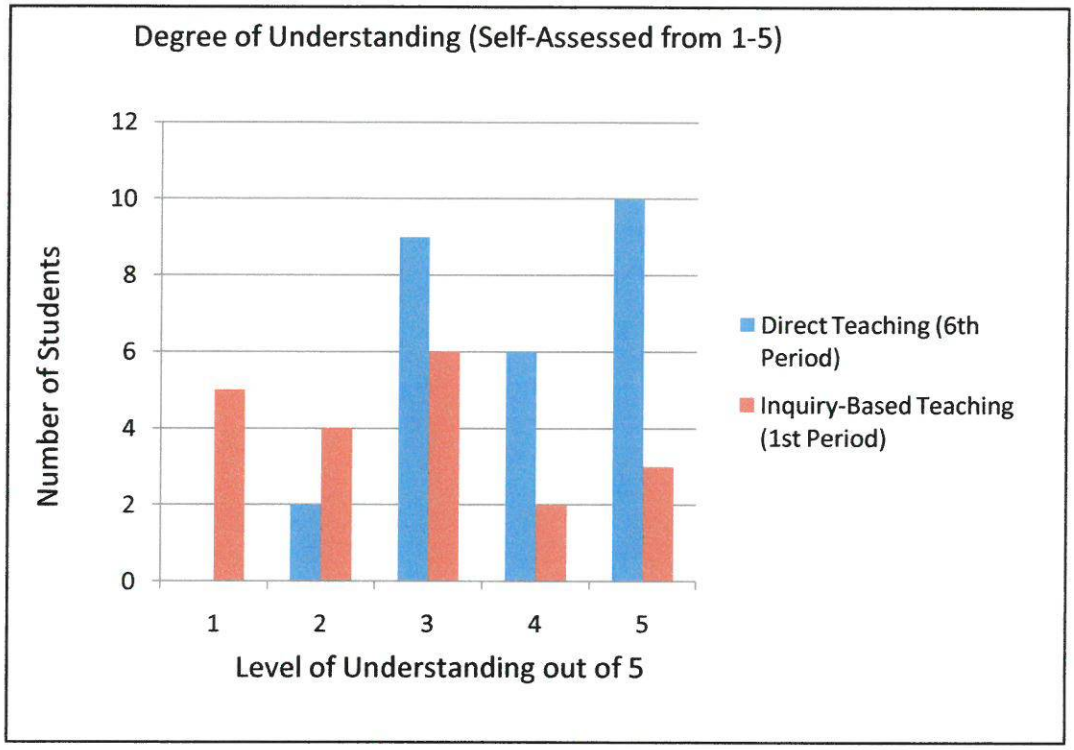


Table 8
Lesson #2: Absolute Value of Inequalities
Level of Understanding Results (1 to 5)



Analysis

Results

In looking at the results from the first lesson on rational functions, Table 1 shows that there were 10 students who received a score of 8 out of 8 on their exit slips and the average score for 1st period (direct teaching group) was a 7.05 or 88.125%. The lowest score in 1st period was 4 out of 8 and there was only one student who had that score. When comparing these scores to the 6th period (inquiry-based teaching group) there were 9 students who scored 8 out of 8 on their

exit slips, which looks comparable to 1st period, but a little more analysis the table shows that their average score was only about 6 out of 8 or around 75%. This is about an entire point or about 12.5% less than the direct teaching group. This data appears that the direct teaching group performed slightly better on their exit slips. This means that they were able to do the math problems better than 6th period, the inquiry based group.

In Table 4, the students in the direct teaching group, 1st period had a higher number of students who rated themselves in the 4 and 5 categories for understanding the material. In the inquiry based group there were several more students who gave themselves a score of 1 and 2, which shows little understanding of the topic.

In the first lesson, the overall results imply that the direct teaching group was more successful in understanding and demonstrating their understanding of the material. These two classes had very similar 1st quarter grades, but these results are still not significant without looking at the second lesson. In the second lesson, the control and experimental group were switched. In this lesson, the 1st period class was taught using inquiry-based teaching and the 6th period class was taught using direct teaching. The material in this lesson was quite a bit more difficult than in the first lesson.

In looking at Table 5 which is the direct teaching group (6th Period) the scores are very good. There are 13 students who scored 7 out of 8 and 3 students who scored 8 out of 8. The lowest score was 5 out of 8 points and the average score was

6.5185 or 81.48%. When these results are compared to the inquiry-based group, the results are significantly different. In the inquiry based group there were 11 students who scored a 4 or below and only 3 students who scored a 7 or 8. The average score was 4.5 out of 8 points or 56.25%. This average is 25.23% less than 6th period's score.

The results of the self-assessed level of understanding are very similar. There were many more students who rated themselves with a 3, 4 or 5 in the direct teaching group than the inquiry based group. In the direct teaching group nobody answered 1 (very little understanding) whereas in the inquiry-based group there were 5 students who gave themselves a score of 1.

In analyzing the results of both lessons, it does appear that the students had a higher overall understanding when they were taught using a direct teaching versus an inquiry based teaching. In addition, it appears that when the material is more difficult, the direct teaching method is significantly better. This can be seen in the difference between Lesson #1 and Lesson #2. In lesson #1, the difference between the average scores in direct teaching and inquiry base teaching was about 12.5%, whereas in the more difficult topic in Lesson #2 the difference in the average scores was about 25.23%. This implies as the level of difficulty increases, the direct teaching method will be more appropriate to ensure better understanding.

Limitations

Although these results show higher scores on the direct teaching groups, there are some limitations of this experiment that need to be mentioned.

First, although I do teach using both methods, overall I teach more often using direct teaching. This means that the students may be more comfortable with this method. For this experiment to be more accurate, the students should be exposed to inquiry-based teaching and direct teaching about the same amount of time.

In addition, this experiment was only using two lessons. In order to have a more accurate picture, there should be many more lessons given using both direct and inquiry-based teaching to have conclusive evidence that one method is better than the other.

Another limitation is that the results were only measuring exit slips, or solved problems. There was no measurement of the conceptual understanding. These students may have made careless algebra errors, but they understand the concepts behind what they learned. A better research project may have included an element where the students answered written questions about the topic to show their conceptual level of understanding.

Implications/Recommendations

In light of the data and analysis is does appear that direct teaching is the most effective method for teaching High School Math. I believe this means that the majority of the lessons that teachers teach should have at least an element of direct teaching. This could be a time at the end of a lesson where the teacher goes through problems with the students or it could be an entire lesson using direct teaching. Although direct teaching is the most effective method for teaching math, I

do not believe that teachers should *only* teach using direct teaching method. As Howard Gardner has taught us, many students learn differently and have different types of intelligences. By only teaching using direct teaching we may be limiting some of our students who possess a high intrapersonal intelligence. Inquiry based teaching can be used to introduce a topic and allow students to explore information with their peers, but there should also be some sort of direct teaching if the students do not come to the correct conclusion about a topic.

The results also imply that our students need more practice on solving problems on their own. Because they had such a hard time learning using an inquiry-based approach, it leads me to the conclusion that they need to increase those problem solving skills. This doesn't need to be an entire lesson that uses inquiry-based approach, but maybe this would look like challenge problems or letting students explore real world data and applications to come up with conclusions on their own. Whatever the method may be, one thing that I would recommend from looking at this data is that teachers need to focus on the perseverance and motivation of our students to become self-learners.

This research has led me to question why our students struggle so much in learning using an inquiry-based approach. The implication is that students do not possess the skills necessary to analyze a situation and investigate a topic on their own. Although direct teaching produces the test results that were analyzed in this experiment, I can't help but question if direct instruction will hurt these students in the long run. If students never learn how to solve a problem on their own, how will

they be successful in their future careers when they are not relying on an individual to teach them all of the information? Although direct teaching produces the desired test results, does it produce the ideal learner?

Conclusion

The data that resulted in this research project is hard to dismiss. The results show that students perform better when they are taught math using a direct teaching approach versus an inquiry-based approach. The results also show that as the level of difficulty increases, the more effective the direct instruction becomes. This data should be analyzed with the mentality of a teacher. The mentality of teachers is that we want our students to *learn*. This means a combination of learning the material, and learning how to learn. Direct teaching is the best method for teaching our students the curriculum of High School Advanced Algebra, but does it teach our students how to solve problems? I think the best method of teaching math is a combination where the majority of lessons are taught using direct instruction, but I do not believe that inquiry-based methods should be forgotten. I think that they are important for teaching our students the perseverance and problem solving that they will need to become well rounded citizens.

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