Differentiated Instruction:

Varying Learning Strategies and the Effect of Student Success

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Introduction

I have always believed that change is inevitable; every new age brings different societal needs. Though the concepts in education might not change, the way teachers present them must. At the beginning of the semester of TE 855 Teaching School Mathematics, we listened to a broadcast from NPR, "Listen to The Way Your Learned Math is so Old School," which not only mentioned the teaching of reformed mathematics but also mentioned how many parents cannot help their child answer or understand math questions. It made me think about how the "old school" way to teach was one-way; usually concepts were lectured, book work was assigned, and students did what they could without asking why. With this method, students either understood the first time, or failed. Nowadays, we cannot leave any student behind. As this semester continued, we discussed new curriculum and teaching for understanding, which made me question if the methods by which I presented new mathematical concepts effectively reached every student. Was I doing enough? Was I a good teacher?

The National Boards of Professional Teaching Standards states that there are five propositions that indicate an effective teacher. First, the teacher is committed to his/her students and their learning. Second, the teacher should know the subjects they teach and how to teach these subjects to their students. Third, the teacher is responsible for managing and monitoring student learning. Fourth, the teacher thinks systematically about their practice and learning from experience. Fifth, the teacher is a member of a learning community ("Redefining Teacher Quality"). As a secondary education mathematics teacher, it is my job to do all that I can to reach every last student. I decided to explore differentiated instruction in mathematics. I know that each student has their own learning style and I should teach to those styles, but I wanted to go further. I wanted to give students multiple ways to learn a concept and the choice to answer questions in a method that suits their understanding.

Math Question

Once I decided to look further into differentiated instruction, I sought to determine if there was evidence that teaching mathematical concepts in multiple ways was beneficial toward student success. If students were exposed to a mathematical concept in multiple ways, would there be evidence to show the benefit of differentiated instruction through student attitude, understanding, and performance. Considering changes in education and unique learning styles, I hope to see that giving my students multiple ways to learn a concept will allow them more opportunity for success. The question for my action research project became, "What effect does differentiated instruction in mathematics have on student performance and success?" This study will examine classroom practices that support differentiation with the purpose of determining if differentiated instructional strategies have an effect on student achievement. There are three components of the curriculum that can be differentiated to meet students' needs: content, process, and product. The content is what the teacher wants each student to know by the end of the unit. The process is the way in which the teacher designs activities to ensure the students learn the content. Products are what the students create to demonstrate their understanding of the content.

Literature Review

Differentiated Instruction is the idea of accommodating the different ways students learn to maximize their growth ("Differentiated Instruction"). When one lesson is designed for all learners, limits are placed on students' levels of achievement. Academically advanced students are left behind because they are under-challenged and struggling students are left frustrated or confused. Classrooms in which differentiation is implemented may help to close the achievement gap. According to Tomlinson (1999), teachers in differentiated classrooms become partners with their students, use time flexibly, and call upon a range of instructional strategies. Educators should offer the best possible instruction to their students. Differentiation suggests that all learners can achieve and be appropriately challenged within any classroom. Educators should know that children have basic needs that must be met before learning can occur. According to Prince and Howard (2002), children need not only to survive but also to thrive in school. In a differentiated classroom, children are free to take risks in their learning because fear is removed. By developing lessons appropriate to students' readiness levels, interest, and learning profiles, teachers will be able to draw upon students' prior knowledge and experiences outside of the school environment. This will empower students to ask questions and share their opinions, because they already have knowledge or interest in the topic. Throughout this process of lesson modification, students are challenged at appropriate levels, eliminating frustration and boredom.

Maslow (1998) emphasized that before higher level needs are even perceived, lower level needs must be satisfied. A lesson designed to meet the learning profile of students would take into consideration the way in which the students best process ideas and manners by which learning style, gender, culture, and intelligence preference influence the students. A student who is confused about a learning strategy will not have confidence in their understanding of a concept, resulting in lack of student success.

If a teacher can accommodate for differences in how students learn, then optimal learning is attainable. Knowing the type of learner the students are is not enough, a teacher must uncover what students know. Pre-assessment is an important tool to assess the readiness of students, which allows teachers to create appropriate lessons and activities. Only after a pre-assessment can a teacher design the lesson.

It is important to design a lesson that challenges students based on their interests, ability, and learning needs. According to Jensen (1998), “Our brain is highly effective and adaptive. What ensures our survival is adapting and creating options. A typical classroom narrows our thinking strategies and answer options. Educators who insist on singular approaches and the ‘right answer’ are ignoring what’s kept our species around for centuries” (p. 16). Research conducted by Dunn, Griggs, Olsen, Beasley, and Gormann (1995) revealed that instructional interventions designed to meet the learning needs of the students showed a statistically significant difference in achievement over those students not being accommodated. Students who are given a variety of ways to learn a concept have the greatest opportunity to succeed.

While the term “differentiated instruction” may be unclear to teachers, the practice itself should not be. All teachers should realize that their students are different in many ways and design their classroom and lessons around the students they have at any given time. There is not a classroom where all students are identical and learn the same way. Stevenson (1992) states, that in order for all students to experience success, schoolwork must accommodate individual differences of talent and development. If the lesson involves multiple strategies, then there is a greater chance that all students will be reached.

Data Collection

Data was collected from the students of two Integrated II math classes. The 47 students were made up of 7th and 8th graders who have been in an accelerated program for most of their scholastic careers. Even though these students were in a higher level math class, there was still a variety of student skill level.

I decided to do my research of differentiated instruction by looking specifically at providing a variety of ways to teach and solve a certain mathematics concept. I took two lessons out of my factoring unit and analyzed how students might prefer certain strategies and how a choice of strategy might impact their scores. Before the lessons were taught, students were given a survey (Appendix 1) to analyze their opinions of past and present math classrooms and how their math teachers taught. Also, there was a pre-assessment (Appendix 2) to analyze prior knowledge and how students approached concepts they had never seen before. With both surveys and knowing my students' strengths and weaknesses, I was able to format these lessons to offer a variety of learning strategies to their benefit. The first lesson involved expanding monomials multiplied by polynomials and polynomials multiplied by polynomials. This lesson stayed within quadratic parameters. I observed my students while they discovered how to expand these expressions using a hands-on method of algebraic tiles and further, how to connect this concept to the distribution property, which they had preciously learned. In the second lesson students learned to factor quadratic equations using algebraic tiles, discovering "rules" and being introduced to the diamond method. Students were told that they could draw the tiles out of they did not want to continue putting algebraic tiles to make a rectangle.

After the lessons, students were then given a survey (Appendix 3) to analyze what they thought of the lessons and the strategies they learned. From there, a quiz (Appendix 4) was given not only to determine whether they needed more time for understanding the concepts, but also to explore which strategy they chose to use to answer questions. A week later the unit assessment was given. For this research paper, I only analyzed the questions that applied to these two lessons. Again, I looked at the strategy they chose and their overall score on those questions. I decided to examine their strategies on the unit assessment to see if the students preferred using the same strategy as the week before and if that had made a difference in their score.

Data Analysis

When looking at the results of the survey (Appendix 1) of past and present math classrooms, I noticed that most students had positive views toward school and mathematics but they were hardly ever given the opportunity to learn multiple strategies to approach a mathematics concept or had the choice to use whichever strategy they wanted to solve a problem on an assessment. This told me that giving them a chance to answer questions in multiple ways was going to increase the chances for students to be able to show their understanding.

The pre-assessment results conveyed to me that close to all students remembered how preform the distribution property. Some students made small mistakes by forgetting to distribute the negative out or not factoring out the common variables. When asked about the area of a rectangle, the few incorrect answers received by students were that students stated how to find the perimeter of rectangle. The pre-assessment scores (Appendix 7) confirmed that students did not know how to expand or factor quadratic equations. All students received a 50 or below. I predicted that scores would improve dramatically after the instructions of the lessons.

During the lessons I was able to see a great change in student attitude. In past years, before I started teaching the algebraic tile technique students seemed to stare at me or the board. Almost 100% of students, in the past, would struggle with factoring equations when there was a greater number than 1 x^2. The introduction of using algebraic tiles and making a connection with the area of a rectangle seemed to bring more understanding of the concepts. I observed students interacting in their groups, asking probing questions, and having that “ah ha” moment.

The survey (Appendix 3) after the lesson confirmed that after the students had a physical opportunity to understand the concept, they appreciated the chance to find solutions by using a different strategy. Some students preferred memorizing rules, like students have done in the past, but almost half the students were keen on being able to solve problems using the hands-on strategy.

I analyzed two components of the quiz, the strategies used (Appendix 5) and the scores (Appendix 8). The results of the strategies showed that when students solved expanding questions, most students used the FOIL method, a memorizing method. Though FOIL was used the most, only ten less students used the algebraic tiles or drawing out the tiles. These results indicate that providing the students a variety of strategies gave more students the opportunity to feel successful. The results of factoring were a little different. Most students chose to perform the memorizing method. It seemed that the more challenging the question and the higher the numbers, the less likely the student was to use tiles. I did find that some students decided to check their answer by performing a different strategy than they first chose. This also showed that having a variety of methods for the students to use enhances the student’s chance to show their understanding successfully. Scores of the quiz improved dramatically from the pre-assessment, which supports the idea that differentiating instruction and providing a variety of ways to learn a mathematical concept increases a student’s opportunity for success.

My initial reason for also analyzing the unit assessment was to see if student fully understood the expanding and factoring concepts rather than just memorizing strategies for that week. During the quiz, I had placed algebraic tiles on their tables but for the unit assessment I kept them on the shelf. I always told students they could use anything in the room to help them show their understanding. Only a handful of students got the tiles off the shelf and used them. The results of the strategies used by students on the unit assessment (Appendix 6) revealed that most students used the memorization methods but I think is because students were able to understand the concepts and have more confidence in their knowledge knowing that they could use the tile if needed. The intriguing part was that multiple students used different strategies on different questions. A student would solve problem 1 and 2 using FOIL but them use drawing of the tiles to solve questions 3 and 4. If students had not learned multiple ways to find the solutions, they probably would not be able to achieve a correct answer. Scores (Appendix 9) revealed that a majority of students improved from the quiz to the unit assessment. Only 2 of 47 students performed below a 77% on the questions in the unit assessment revolving around the two lessons. Scores that went down only went down by 2%; this is likely the result of the students making an operation error.

Actions, Reflections, and Conclusions

With the improved assessment scores and positive response from students, I will continue to differentiate my instruction, providing multiple ways to approach a mathematical concept based on the students I am teaching. I believe from past experiences with expanding and factoring concepts that teaching multiple methods gives more students an opportunity for success. By differentiating the methods taught, students are able to have the option to choose how they want to prove that they understand a concept. Knowing the types of learners my students are and knowing what they know helps me determine how to differentiate my instruction, ultimately leading to their success.

While focusing on the types of strategies my students chose, I wondered whether or not students choose a certain strategy based on the type of question, in this case, straight forward expressions or word story problems. I made sure to differentiate the questions I was asking the student so my next step would be to analyze how the strategies varied with the type and difficulty of the questions. I would also like to analyze my differentiated instruction in another unit with different concepts and how it meets every student's needs.

To teaching a variety of strategies takes time, time to find the teaching strategies and time for the students to learn them. Though it may be difficult to do this for every mathematical concept, it provides optimal learning opportunities for all students. With this, I will be starting a faculty folder in which math educators can share different strategies with fellow co-workers for each unit. If teachers share what they know, there is more reason to differentiate instruction, leading to more student achievement.

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Student Survey (Appendix 1)

Circle the best answer that relates to you.

1. Do you like school?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
2	**31**	**13**	**1**	

2. Do you enjoy learning Mathematics?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
1	**29**	**15**	**2**	

3. Rate the work you do in Math class (past and present)?

Too Easy	Sometimes Easy	Just Right	Sometimes Difficult	Too Difficult
2	**15**	**13**	**17**	

4. In Math, how often do you:

Have choices in projects or assignments?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
		4	**14**	**29**

Do work from your math book?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
12	**29**	**5**		

Work in groups?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
41	**3**	**3**		

Group members change?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
		45	**2**	

Memorize rules to find solutions?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
38	**8**	**1**		

5. In Math, how often does your teacher:

Provide more than one way to learn a concept?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
		19	**20**	**8**

Let you solve problems in multiple ways on an assessment?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
	2	**8**	**16**	**21**

Unit- Fun with Factoring Pre-Assessment (Appendix 2)

Answer each question to the best of your ability. Show all your work. Circle final answer.

1. How would you solve for the area of a rectangle?

Expand

2. $5 (a - 8)$
3. $-3b (2a - 4b)$
4. $(x + 5) (x + 3)$
5. A backyard has a fence length of $x + 2$ and a width length of $x - 4$, what is the area expression of the backyard?
6. $(y - 5)^2$

Factor

7. $8w^4 - 12$
8. $21x^2 - 28x^3y$
9. $m^2 + 4m + 3$
10. A surveyor's map shows a plan for a rectangular rose garden whose area is $a^2 + 25a - 350$. Find an algebraic expression for the length and the width. If $a = 200$ ft., find the actual dimensions of the garden.

Student Survey – Lesson 1 and 2 of Unit Fun with Factoring (Appendix 3)

Circle the best answer that relates to you

1. How were the lessons?

Too Easy	Sometimes Easy	Just Right	Sometimes Difficult	Too Difficult
	2	**38**	**3**	**4**

2. How often did your group communicate?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
10	**28**	**8**	**1**	

3. How often did you work alone?

All the Time	Most of the Time	Some of the Time	Almost Never	Never
	1	**8**	**27**	**11**

4. What did you like about the lessons?

-Variety of ways to solve –working with the tiles –working with my group –the problem solving –FOIL is easy

5. What did you dislike about the lessons?

-Number other than 1 in front of x^2 –the red tiles –Ms. Heckman wouldn't answer my questions –my group took over the tiles and I just sat there

6. Did you prefer to use double distribution, FOIL, or tiles/drawing tiles when expanding?

DD – 0
FOIL- 32
Tiles/Drawing- 15

7. Did you prefer the use "rules", diamond method, or tiles/drawing tiles when factoring?

Rules- 23
DM- 5
Tiles/Drawing- 19

Quiz- Expanding and Factoring Quadratic Equations (Appendix 4)

Expand these problems using any method of your choice. Show all work. Circle your final answer.

1. 3x (2x – 3)

2. (2x + 6) (3x + 2)

3. (x – 1) (2x + 4)

4. (5x + 2) (5x – 2)

5. The length of a rectangle cloth is 3 in. more than its width. Find the area expression of the cloth?

Factor by any method of your choice. If the quadratic is not factorable, then write NF.

6. $2x^2 + 7x + 3$

7. $x^2 - 8x + 15$

8. $y^2 - 10y - 24$

9. $w^2 - 49$

10. The product of two consecutive odd integers is 99. Find the integers.

Quiz Analysis – Expanding and Factoring Process (Appendix 5)

	1	2	3	4	5	6	7	8	9	10	Total
Double Distribution	45	3	2	2	15						67
FOIL	0	27	27	35	0						89
Tiles/Drawing (Expanding)	2	17	18	10	32						79
Rules						10	25	26	42	24	127
Diamond Method						15	5	6	3	1	30
Tiles/Drawing (Factoring)						22	17	15	2	0	56
Inverse Operation										32	32

Unit Test Analysis- Expanding and Factoring Process (Appendix 6)

	2	3	4	5	6	8	9	10	11	12	Total
Double Distribution	44	2	2	2	13						63
FOIL	0	32	33	35	0						100
Tiles/Drawing (Expanding)	3	13	12	10	34						72
Rules						15	29	26	40	7	117
Diamond Method						12	7	4	3	0	26
Tiles/Drawing (Factoring)						20	11	17	4	0	52
Inverse Operation										40	40

Pre-Assessment Scores (Appendix 7)

Percentage	# of Student
100	0
90	0
80	0
70	0
60	0
50	21
40	7
30	5
20	10
10	4
0	0

Quiz Scores (Appendix 8)

Percentage	# of Student
93-100	18
90-92	9
87-89	3
83-86	6
80-82	0
77-79	2
73-76	0
70-72	6
67-69	0
63-66	2
60-62	0
59 and Below	1

Unit Assessment Scores (of questions revolving around the 2 lessons) (Appendix 9)

Percentage	# of Student
93-100	14
90-92	12
87-89	3
83-86	7
80-82	8
77-79	2
73-76	0
70-72	0
67-69	0
63-66	2
60-62	0
59 and Below	0