

# Moving All Students towards Mathematical Success: Teachers' Perceptions of Learning and Implementing Differentiating Instruction

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*This article discusses a study of five teachers as they journeyed through a differentiated instruction course where they were taught how to meet the needs of learners in inclusive classrooms. First the article discusses the challenges teachers face when working to meet the needs of students in diverse classrooms. Next, the article reports on three case studies describing the changes five teachers went through as they worked to differentiate the content for their classrooms. Finally, challenges and successes experienced by the teachers differentiating instruction are shared.*

**Keywords:** Inclusion, differentiated instruction, teacher education.

“They have to do spreadsheets. That's the bottom line. When they leave my class they understand how to complete a spreadsheet. There is no differentiation. A spreadsheet is a spreadsheet” said Tammy, a high school accounting teacher. Sandra, a third grade teacher, chimed in and said, “I can't differentiate when I have a classroom full of boys with behavior problems.” Second grade learning support teacher, Lisa, expressed “Inclusion isn't the best option for my students. They need more help than a differentiated inclusive classroom can give them. They need more small group and individual instruction at their own level and pace.”

This is how our summer course for K-12 teachers on differentiating in the mathematics classroom began.

## Rationale

As the student population continues to diversify, all disciplines need to find ways to better meet the different learning styles of their students. One discipline in which this is particularly challenging is mathematics. The primary focus of mathematics is on problem solving, and this has led to mathematics

being taught in a way that emphasizes procedures over conceptual understanding. The traditional mathematics teaching approach involves showing students how to solve mathematics problems, and then asking the students to practice these problem-solving techniques. Most mathematics teachers believe very firmly in this teaching method. They assume that as students practice solving mathematics problems, the students are developing an understanding of the concepts on which the problems are built.

According to the National Council of Teachers of Mathematics (2000) “learning mathematics without understanding has long been a common outcome of school mathematics instruction ... and has been a persistent problem since the 1930s” (p. 20). This problem has led to countless students memorizing facts and problem solving strategies rather than developing conceptual understanding. To solve this challenge, teachers need to give students mathematical experiences that make sense to them, that connect with their prior knowledge, and that are applicable to their lives. Developing a broader range of methods for teaching mathematics can not only help meet the needs of diverse students, but can also help more students learn concepts rather than problem solving tricks.

According to the United States Department of Education, nearly 42 percent of all students in U.S. public schools are students of color, approximately 20 percent are second language learners, and approximately 14 percent have an identified disability. Almost half of the students who have an identified disability spend 80 percent of their school day in general education classrooms. It is not always possible to get every student to exactly the same point in the curriculum at exactly the same time; however, it is possible to guide most students through the curriculum in a way that helps them achieve desired standards (Voltz, Sims & Nelson, 2010). The diversity of the student population and the expectation that all students can achieve high standards requires a shift in instructional practices and design. Differentiated Instruction can be instrumental in meeting this goal.

This article will discuss teaching out of your comfort zone, the theoretical framework under which the course described in the study was developed. The article will discuss a differentiated instruction study that profiles five teachers as they journeyed through the differentiated instruction process to meet the needs of learners in inclusive classrooms. Of course calling for change is much easier than creating it. Most teachers like to teach the subject they know the same way they learned it. This makes sense since being familiar with a teaching method gives teachers confidence. Unfortunately, using only one repeated teaching style has grown less effective over time because today’s students are more and more diverse and have a wider range of learning styles and educational needs. Teachers need to develop an awareness of students’ readiness, interests, and learning profiles (Tulbure, 2012).

This is certainly applicable to the mathematics classroom where memorizing formulas and rules tends to be the norm. While this procedural

approach to teaching and learning mathematics may make sense to a given teacher, it may not suit all students. Plug and chug approaches to teaching mathematics often leave students with poor conceptual understanding. While a one-size fits all approach to teaching mathematics no longer works given the diversity of the student population, it is also unreasonable to expect teachers to design a different activity for each and every individual student in a class. What teachers need, therefore, is how to develop a broad range of learning activities from which students can choose while teachers also stay within their teaching comfort zones.

Therefore this study sought to answer the following research question: How do K-12 teachers respond to being given the opportunity to learn and implement methods for differentiating instruction?

### **Literature Review**

Differentiated instruction is a model of instruction that embraces an engaged, student-centered, constructivist approach to teaching and learning. The three key elements of differentiated instruction are: 1) readiness, 2) interest, and 3) learning profile (Allan & Tomlinson, 2000). These elements form the philosophical and theoretical basis of this approach.

Student readiness is as diverse as the classroom population. Readiness involves multiple factors that can affect the level of difficulty at which a student learns and achieves. A theoretical basis for readiness can be understood through Lev Vygotsky's zone of proximal developmental (ZPD). According to Vygotsky (1978), the ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers" ( p. 86). Interest can be considered one of the mitigating factors of readiness. The more interested a student is in the content, process, or product being studied, the more the student's level of readiness will be positively influenced.

The researchers Thousand, Villa, and Nevin (2007) contend that the process of differentiating content, instruction and assessment begins by knowing your students. Teachers need to apply a universal design approach and gather information about their students' strengths, interests, learning styles, preferences, and intelligences. The theoretical work of Kolb (n.d.) on learning styles and Gardner (2011) on multiple intelligences provide a framework for assessing students' learning profiles. Understanding students' learning profiles is essential; however, understanding how a teacher's own learning profile affects his or her instructional practices is equally important.

### **Methods**

This study reports on a collaborative project where a mathematics

professor and a special education professor designed and helped K-12 teachers implement successful differentiated instruction strategies for diverse learners in math. The researchers examined how teacher educators from different departments working with in-service teachers from the local community could work together to successfully meet the diverse needs of students in K-12 classrooms. This study looks at efforts to link special education and mathematics.

### **Research Site**

Participants for the study were from the same school district located in Western Pennsylvania. The rural district serves more than 2,700 students from four surrounding boroughs or townships. District facilities consist of two PreK-3 elementary schools, two 4-5 elementary schools, one 6-8 junior high, and one 9-12 senior high school. An alternative school is also located in the district serves grades 7-12.

### **Participants**

Twelve teachers participated in a week-long full day instruction in the summer followed by three additional meetings held throughout the following school year. The composition of teachers included: 4 high school teachers, one of whom was teaching in an alternative school setting in the district for students with behavioral issues, 1 kindergarten teacher, 1 fifth grade teacher, 2 fourth grade teachers, 1 third grade teacher, 1 second grade teacher, 1 elementary level ESL teacher, and 1 learning support teacher. The teachers were required to select a minimum of one unit of study that he or she would revise based on the content presented in the week-long summer meeting to implement with their students. The units needed to include both a pre and post-test and be implemented during the school year. Teachers were required to present the results of their efforts to incorporate differentiated instruction into their inclusive classrooms at the end of the school year.

### **Research Method Design**

This research project used a case study methodology. A case study design was chosen because of the small number of participants in the study as well as the yearlong implementation of the differentiation strategies. The case study designed used was modeled on case study research methods developed by Yin (2013), Hancock and Algozzine (2011), and Gerring (2007).

### **Data Collection**

A week long, full day workshop was designed to teach the essential concepts and theoretical framework of differentiated instruction. The workshop presented one to two new strategies to the participating teachers each day through hands-on activities employing the differentiation strategies. Exit slips were used each day to monitor learning by the teachers and to address any

questions or misconceptions they had. On days 1 and 2, the teachers were introduced to and explored:

- Their own personal learning style and how that did or did not correlate to their teaching style.
- The framework of Universal Design for Learning (UDL) and Differentiated Instruction (DI).
- Strategies to identify student interests and learning style preferences.
- Identification and writing the essential questions.
- A modified version of lesson planning introduced by Thousand, Villa & Nevin, (2007) to guide their unit planning (Figure 1).

Two new differentiated strategies were taught on each of days 3, 4, and 5. Strategies were taught using hands-on activities. The six new strategies included: Anchor boards, Cubing, Think Dots, Think-Tac-Toe choice board, Menus, and R.A.F.Ts

Teachers were asked to think about and incorporate at least one of the differentiation strategies into their unit plan. By the end of the first week, the teachers described their ideas for implementing differentiated strategies throughout the school year. The researchers monitored the teachers throughout the school year. Based on teacher feedback and perceived teacher needs, the researchers focused the three subsequent class sessions, on addressing those needs and providing feedback on the progress of the teachers' final presentation project.

The data collected included the end of year presentation by the participants in the study as well as a reflection paper discussing the benefits and challenges the teachers saw throughout the school year as they worked to differentiate their instruction.

It was a tall order to span the whole K-12 grade levels but perhaps the greater challenge was the focus on mathematics with teachers who perceived differentiation as difficult and not conducive to teaching mathematics.

## **Results**

As shared in the opening quotes in the introduction the participants at the beginning of the workshop were less than enthusiastic. It became clear almost immediately that the concept of differentiating mathematics raised a great deal of skepticism. The following three case represent a cross-section of the teachers who participated in this project. Responses and reflections from the remaining seven teachers are included in the Discussion section of this article.

<b>LESSON PLANNING PHASE</b> Content Area: _____ Lesson Topic: _____	
<b>Facts about Student Learners</b> <ul style="list-style-type: none"> <li>• Who are my students and how do they learn?</li> <li>• What are the students' strengths, languages, cultural backgrounds, learning styles, interests?</li> <li>• What are their multiple intelligences?</li> <li>• What forms of communication do my students use?</li> <li>• Are there any students who require differentiation in the content, process or product?</li> <li>• Accommodations for students with IEPs or 504s</li> </ul>	
<b>Content (What will students learn?)</b> <ul style="list-style-type: none"> <li>• What is the Essential Question or Concept?</li> <li>• Objectives and standards</li> </ul>	
<b>Evaluation (How will students show success?)</b> <ul style="list-style-type: none"> <li>• In what ways will the learning outcomes be demonstrated?</li> <li>• Tests</li> <li>• Authentic products</li> <li>• What criteria will the teacher use for evaluation?</li> </ul>	
<b>Process of Instruction (How will students be instructed?)</b>	
<b>Instructional Arrangements</b> (some examples given) <ul style="list-style-type: none"> <li>• Cooperative learning structures</li> <li>• Cross age peer tutors</li> <li>• Independent</li> <li>• Whole group</li> <li>• Teacher directed small group</li> </ul>	<b>Instructional Formats</b> (some examples given) <ul style="list-style-type: none"> <li>• Lecture</li> <li>• Experience based</li> <li>• Activity based</li> <li>• Discovery learning</li> <li>• Group investigation</li> <li>• Activity based</li> <li>• Learning centers</li> <li>• Integrated-cross curricula</li> </ul>
<b>Instructional Strategies</b> (some examples given) <ul style="list-style-type: none"> <li>• Use of taxonomies</li> <li>• Graphic organizers</li> <li>• Research based strategies</li> </ul>	<b>Social and Physical Environment</b> (some examples given) <ul style="list-style-type: none"> <li>• Room arrangement</li> <li>• Using space outside of the classroom</li> <li>• Teaching cooperative learning roles and responsibilities</li> <li>• Social norms (class rules)</li> </ul>

**Figure 1.** Lesson planning phase worksheet.

### Case study 1: Sandra.

Spirited discussion took place on the first morning of the workshop that was to begin the research project. Sandra, a third grade teacher, expressed that she was using differentiation on a regular basis but “with the students I have this year, it is just impossible. I have all of the lowest performing boys in the third grade class with lots of behavior issues.” Sandra was confident that she had a very good grasp of mathematical concepts and believed that she was an effective teacher. Throughout the course Sandra insisted that she was already

differentiating. She shared a Think-Tac-Toe activity with the other teachers in the group (Figure 2).

Explain on the Promethean Board how to solve these problems: $10 \times 10$ and $20 \times 6$ two different ways	Create 3 input/output tables for the threes, fours, and fives tables. Use the templates.	Use the error correction journal to explain why Raphael missed his multiplication problem
Design a poster that helps students multiply the problem $25 \times 3$ . Explain the steps or ways to solve the problem.	Solve 10 multiplication #1-10 on the worksheet.	Use tally marks, circles, and counting to solve these problems $5 \times 5$ ; $5 \times 7$ ; $5 \times 9$
Draw pictures that show these multiplication facts: $3 \times 4$ , $3 \times 8$ , $4 \times 6$	Create a rap, poem, or song about skip counting.	Create a concentration or Uno type game with small cards. Use a multiplication fact on some cards and the answers on others.

**Figure 2.** Sandra's Think-Tac-Toe.

Although Sandra's strategies may have been varied, her mindset about the value of student diversity was not aligned with the principles of differentiation. It was clear that she needed to shift paradigms, the teachers like Sandra in the study needed to be taught that differentiation is a way of thinking about teaching and learning that values individuality and can be demonstrated in a variety of classroom practices (Tomlinson, 2002).

### Case study 2: Lisa and Alecia.

Lisa, a learning support teacher, and Alecia, a third grade teacher, routinely worked together throughout the school year. They felt it was a logical choice to complete the differentiation unit together. When the study began Lisa was doing pull-out services for third grade in reading and mathematics and Alecia was teaching third grade. The two had decided to do a unit on fractions. Three weeks before school started, Alecia was assigned to second grade and Lisa was to co-teach reading and math within the regular education classroom. Lisa struggled with the idea of full inclusion and felt that she was definitely helping students who were struggling but not-identified. However, she feared that she was having a limited effect on students with learning disabilities in this inclusive setting. Alecia struggled with a lack of co-planning time and teaching at a new grade level. Both teachers were experiencing change and now would be adding to that by differentiating instruction for a class of 17 students represented by students with learning disabilities, an English Language Learner, as well as a range of ability levels from low average to gifted, a truly inclusive classroom.

Lisa and Alecia chose to explore the essential question. "Where do we see fractions in our lives and how do we use them?" Throughout this unit, Lisa

and Alecia used a variety of instructional strategies that included food as fractions, children's literature about fractions, clocks teaching  $\frac{1}{2}$  and  $\frac{1}{4}$ , art activities, paper folding, Think-Tac-Toe practice, a cubing activity and a culminating activity of using fractions to follow a recipe, make brownies and divide the brownies into pieces.

Differentiated instructional arrangements were used as well as co-teaching approaches. Students were assessed with an interest survey pre-instruction, pre-posttests from the chapter, performance on center/station activities, Promethean board games and activities, anchor board activities and review cubes

Despite the wide array of strategies and assessments, Lisa was unconvinced that her students with learning disabilities received the instruction they needed in basic mathematic skills. However, Alecia saw things differently. She reflected that, "When learning about fractions or even geometry, students who otherwise might struggle with math, sometimes do really well and gain math confidence. We saw this happen with this group of students as well." Other math concepts were taught in using a traditional procedural method with individualized adaptations throughout the remaining school year and both Lisa and Alecia felt that students with learning disabilities did not gain the same deeper conceptual understanding using procedure only that the students gained when the instruction was differentiated as with the fractions unit. Reflecting on both methods of teaching, Alecia felt differentiated instruction can work but administrators need to make necessary staffing and collaborative planning time available.

### **Case study 3: Tammy and Francine.**

From the beginning both accountancy teachers were nervous about the amount of content they were expected to cover in their classes. While there is no state testing on the material they teach both teachers very dependent on their textbooks and were concerned that perhaps the objectives of this differentiation study would require them to give up their textbooks. An initial concern as well by the teachers was about the immense amount of work and record keeping that differentiating a lesson would entail. Based on previous work they had done on cooperative learning, both teachers commented that incorporating differentiated instruction into their classrooms would be very involved and would require the teacher to manipulate a lot of data. The teachers also expressed concern was also expressed regarding the workload in terms of the number of preps high school teachers have and the amount of time devoted to creating/differentiating activities. However, both teachers talked about a commitment to not resisting change and keeping an open mind about the value of working to meet the needs of all students.

Both teachers began their differentiation unit by identifying an essential question for the topic. From here they decided that it was important to find out something about their students' learning styles. They started by looking at



assessment data from the Pennsylvania System of School Assessment (PSSA) and Northwest Evaluation Association (NWEA) to assess students' ability to read and interpret material independently. In addition, because the teachers were working with two different grade levels, they also wanted to consider differences in background knowledge. While both teachers did use some traditional instructional formats such as lectures and PowerPoint presentations, they also tried a variety of instructional arrangements such as working in groups, pairs, or individually depending on what they felt the students needed. These two teachers began to differentiate instruction by including some of the instructional strategies presented throughout the differentiation workshop, in particular cubing and RAFT activities (figure 3). The differentiated activities were used primarily as review activities towards the end of the unit.

Role	Audience	Format	Topic
Income statement	Statement of Changes in Owner's Equity and Balance Sheet	Love Letter	Explain why you are so important to the Statement of Changes and why you need each other
Worksheet	Confused high school student	Procedural letter	To provide tips on what to remember when closing entries
Capital account	Temporary accounts	Explanatory letter	The importance of transferring your balances into my Capital account

**Figure 3.** RAFT Activity using in an accounting class.

In their final reflection, the teachers commented on how the differentiated instructional strategies increased their students' abilities to apply and retain more information. The teachers also felt that all students were better able to relate to the math material. These conclusions were drawn from looking at scores on the unit tests and comparing them to the previous year's scores where students were presented the same material but did not have the differentiated strategies throughout the lesson.

### Discussion

When the differentiation study began both the general and special education teachers were skeptical and overwhelmed at the thought of differentiating their mathematics classrooms. There was some resistance to the paradigm shift from a procedural mindset to a differentiated instruction mindset. The teachers saw many advantages to using differentiated instruction

in their mathematics courses, but they also worried greatly about challenges. Throughout the year, the teachers tried varied instructional arrangements, formats, strategies and activities. Some teachers only tried one or two differentiated teaching strategies while others implemented four or more.

### **Challenges**

Teachers consistently identified the labor intensity to plan and implement some of the differentiation strategies. Time was something that the teachers felt was more compressed and less available. The teachers also believed that a diverse inclusive classroom took more professional collaboration and co-planning. The teachers felt administrators need to support efforts to differentiate by looking at more flexible scheduling to allow for co-planning and preparation. Another concern was the pressure to prepare students to pass state assessments. The teachers believed that in order to have students prepared for the assessments; they had to cover a breadth of material and were fearful to move away from the text. Finally, increasing student responsibility for their own learning and engagement in differentiated activities can be difficult especially if the students have learned over the years through more teacher directed instruction. Teachers identified the following challenges as primary:

- Some strategies take much more time to plan
- Lack of time to prepare
- The pressure to “finish” the text and prepare students for standardized tests
- Lack of time to collaborate
- Not enough professionals in the room to handle group formats and different activities
- Getting students who are not used to working independently to sustain engagement

Despite these challenges, the teachers did identify many benefits and successes from learning how to differentiate their teaching methods.

### **Successes**

The teachers felt that their students definitely benefitted from the use of differentiated strategies. The teachers described that students gained confidence in math, felt empowered, appreciated the freedom of choice in these strategies, and demonstrated active engagement. The use of a think-tac-toe helped teachers to push students to higher levels of thinking and performance. The accountancy teachers stated that their students applied and retained more information and were better able to relate to the material once it was differentiated.

The teachers also benefitted from the use of differentiated strategies. One teacher described how the anchor board and think-tac-toe were conducive for classroom management when students finished work at different times.

Several teachers stated that although some strategies required more time and effort to plan and implement, others were quick, easy, and effective. One teacher said, "I knew what differentiated instruction was, but this class took it to a whole new level. Not only did it give me new ideas, but it also made me try other approaches that I was not as comfortable with." This teacher also indicated that it made him think more intentionally about what he wanted his students to get out of each and every lesson. The teachers identified the following successes as noteworthy:

- Anchor boards were very helpful when some students finished early and needed filler activities
- The think-tac-toe provided choice and pushed learning expectations. Students enjoyed the freedom of choice in these activities.
- Students applied and retained more information and were better able to relate to course material.
- Some students appeared to gain math confidence through the differentiated units.
- Student engagement increased, as illustrated by this student comment: "It was kinda easy and kinda hard at the same time, but it was definitely fun"
- Enhanced teacher ability to plan effectively differentiated lessons

The teachers also asked their students what the students thought of the differentiated activities they were required to complete as part of their math or accountancy classes. Both the elementary and high school students reported that they enjoyed working on these activities and in particular liked the idea of choice. The following are a list of positive comments from the students about differentiated lessons they were given:

- Fun & learning
- Fun to solve problems that were challenging
- Good practice/helped me understand more
- Liked writing a word problem
- Liked rolling the cube
- Liked working in groups
- It was hard waiting for my turn

### **Conclusion**

Based on the findings listed above, several conclusions can be drawn from this study of teachers being taught how to implement differentiated instruction into their classrooms. First, having follow-up meetings with the group of participants throughout the academic year provided the teachers with opportunities to address concerns or issues they were having throughout the differentiation implementation process. These meetings allowed for practiced-based discussions to occur as well as additional differentiated instruction strategies to be presented when the teachers felt they were needed.

As teachers came to understand the differentiation approach, many experienced a paradigm shift. That is, many of these teachers began to value differentiation methods once they understood them. Teachers said they felt they were learning what it meant to really design instruction, to focus on big ideas and to learn how to use a variety of resources. Teachers also said they began to question the role of worksheets in their classrooms, looking instead for more diverse ways to engage their students. The teachers also said that taking part in this study provide them with new opportunities to be creative. Finally, teachers also said that they now realized it was important to remain flexible with their instructional plans.

By spending time getting to know their students learning styles, these teachers were able to allow students choice when it came to selecting activities that matched their abilities. This encouraged students to challenge themselves even if they needed some guidance and encouragement along the way.

Overall the project did answer the question the researchers had set out to investigate: How do K-12 teachers respond to being given the opportunity to learn and implement methods for differentiating instruction? Perhaps Sandra said it best, “Before this project, I knew that differentiation instruction was adjusting your instruction to meet all learners. After this class, I know that it is much more.” This research study indicates that this project helped some mathematics teachers make a needed paradigm shift from instruction that focuses only on a procedural and problem solving teaching approach to a more conceptualized approach to differentiating mathematics teaching in order to meet diverse learners’ needs.

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