

DIFFERENTIATED INSTRUCTION IN THE HIGH SCHOOL
MATHEMATICS CLASSROOM

By

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STATEMENT BY AUTHOR

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Differentiated Instruction in the in the High School Mathematics Classroom

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The purpose of this research paper is to address the challenges of instruction within a classroom whose census is a diverse mixture of student mathematical abilities. The diverse ability of low and high achieving students all required to master the different strands of mathematics creates problems for instructors and students to stay engaged and actively moving forward deepening and widening their knowledge base. This paper will focus on differentiated lessons, assessments, and projects of a mathematics classroom in a public high school.

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CHAPTER 1: INTRODUCTION

The purpose of this paper is to research educational strategies to address the challenges of educating low and high achieving students in a cohesive classroom setting. For the past nine years, this educator has observed that students have great difficulty engaging or displaying interest in their education, when the curriculum is either beneath or above their current level of educational achievement. When educators choose not to address students' educational frustrations, these students act out, eroding the class morale, jeopardizing a positive learning environment, and halting the growth of each student's education. Mediocre students slide along through their education, waiting for the sound of the bell and their escape to another class or the end to their incarceration. Throughout history educators have been challenged to meet all students' educational needs.

The history of education leads a reader through various education reform movements, standards, and best teaching practices. Education options appear to have a common thread which is to educate all students to their greatest personal potential. Whether the current plan or reform is government, district or teacher driven, they agree that each student must be challenged and the educational goal achieved for the student to become a viable addition to society.

STATEMENT OF THE PROBLEM

Remote rural high schools share challenges similar to their sister schools located in highly populated urban districts. One common problem shared by all schools is the development of curriculum and the process of educating with a common goal set by the state to achieve successful students with limited resources and extreme educational abilities. Small rural schools find this challenge heightened due to the school census that drives the problem of financial affordability, which results in a “one section” school, with one qualified educator to teach all students of mixed abilities in one class period. In schools where the census allows for more than one educator per topic, students self track; they choose classes at their ability or interest level.

The demographics of the rural school students which the author is charged with educating include students within a 60 mile radius of the school. These students come from families that are involved in farm, industry and business occupations as well as families who are unemployed. Students are from homes with one, or two parents, stepparents, situations of varying economics, and similar to other schools of its size. The school houses preschool through twelfth grade, 250 students, cooks, janitors, administration, volunteer grandparents, paraprofessionals and one teacher for each grade level preschool through grade six. The seventh to twelfth grade students find themselves facing six years of each discipline delivered by the same teacher for English, science, mathematics, and social studies along with elective courses. Students and teachers must find a way to respect, encourage, and challenge each other for the next six years including a 90 day break during the summer of each year. However, some students become lost and frustrated, passed through the educational system. The author of this paper is one educator in such a classroom. The

educator in a “one section school,” and the author of this paper, will explore options, research, and create discussions to achieve individualized successful learning for each student.

The question posed by this author is how the high school differentiated mathematics classroom addresses the challenges of educating low and high achieving students in a cohesive classroom setting.

RESEARCH QUESTIONS

How do teachers successfully achieve the required level of education so students are prepared for career and college options in a one section school with the hurdles of state mandated student success, and the economic constraint of a one section school?

How can students of mixed abilities be challenged in the same classroom? What is the history and development of differentiated instruction? The subjects will be the ninth grade Algebra classroom.

SIGNIFICANCE OF THE RESEARCH PROBLEM

Today's economic issues have created budget issues for schools. Small schools and schools forced to reduce teachers due to budget cuts are similar as neither is able to offer multiple sections of mathematics per discipline, making the research of differentiated mathematics classrooms significant.

Through the history of American education, the problem of individualized success has been researched and dealt with in numerous ways. Taking the approach of just being "dealt with" is no longer an option, nor should it be, as all students are required to succeed at a predetermined level. All students in today's society must achieve success to their greatest potential. In large districts, students have options within their schedules that allow them to proceed through their mathematics curriculum at a personal level of ability, engage in their school day, and choose their instructor. This "choice" can be paralleled with the educational strategy of tracking. Students select to follow a lesser educational track due to their lack of success in the mathematics classroom. This leaves high school graduates with a deficiency in their education. These deficiencies manifest causing the high school graduate, now a college freshman or member of the workforce, to continue his or her inadequacy. The student can either choose to stop the pursuit of their education and settle for a minimum wage job and lifestyle or fight their way through the system. This means additional classes and expenses to reach the level of success that should have been achieved earlier in their

education. This deficiency in mathematics education must be resolved. Research on differentiated instruction supports the idea that more students can be successful.

DEFINITION OF TERMS

Ability grouping is the practice of placing students of compatible skills or needs in classes or in groups within a class.

Choice boards are organizers that contain a variety of activities. Students are allowed to choose a specified number of activities to complete as they learn a skill or work on a project. Well organized choice boards can insure there are required components/ lessons that are completed to insure equitability, as well as challenged but not frustrated.

Cluster grouping is defined as a group where all students in a group learn the same coursework together and share responsibility for the success or failure of their group work. In addition, students learn from each other and support each others' efforts. It is typically thought of as a form of heterogeneous grouping, and its advocates recommend that it be used in heterogeneous settings (Burnett, 1995).

Compacting according to Reis is the technique of adjusting curriculum according to student knowledge base. If students have mastered an instructional option it is replaced with challenging material (Sally Reis, 2008).

Detracking is defined as the antonym of tracking. In the United States this term, according to Staples (2008), is used to show when there is not a tracking practice.

Differentiated classroom curriculum according to Tomlinson as the modification of curriculum and instruction to meet the need of individual learners through content, process, product, and/or learning environment. (Tomlinson C. A., 2003).

Differentiated instruction defined by Reed (2004) as the differentiated lessons are to include direct instruction, small group sessions, open-ended questions, and an assessment process. Reed continues that the differentiated instruction is based on instructional elements that grow positive learning environments. Brain based research, learning styles, multiple intelligences and authentic assessments all play roles in the skilled educator's use of differentiated instruction.

Flexible grouping is a grouping strategy that often explores several organizational patterns for instruction. Students are grouped and regrouped according to specific goals, activities, and individual needs (Valentino, 2000).

Heterogeneous grouping is the grouping of students with mixed academic ability levels allowing the possibility of flexible, cluster, and interest/center groups.

Homogeneous grouping is the grouping of students with the same academic ability levels it is also synonymous with ability grouping or tracking.

Interest Center/Grouping allows students to be sorted according to assessments of their ability; some schools have allowed students to sort themselves into groups according to their own interests (Burnett, 1995).

Learning contracts begin with an agreement between student and teachers. The agreement may involve freedoms and choices to complete the task with agreed upon specifications. According to Tomlinson the contract must include a skill component, content component, a time line and an agreement (Tomlinson, 2001).

Tiered assignments are parallel tasks at varied levels based on student readiness and performance with the same understanding and goal as the end result building on prior knowledge to continue the growth of the (Williams, 2010).

Tracking is a structure whereby students are grouped for course taking based on perceived ability, although other factors may influence this organizational structure such as parents and personal choice (Nancy Carey, 1994). These grouping practices involve a group of like-minded, similarly capable students (Staples, 2008). Tracking is also synonymous with homogeneous grouping

Summary Statement

The author is a secondary mathematics teacher in a small rural school with students possessing a large range of mathematical abilities. She is looking for a way to meet the needs of all her mathematic students. Differentiated instruction appears to have the most promise and the

purpose of this paper is to determine if students in the author's classroom would benefit from differentiated instruction.

Chapter 2: Review of Literature

PRECURSERS OF DIFFERENTIATED INSTRUCTION

A hierarchical structure of mathematics education leans educators toward thinking that students must be ranked, and placed in groupings by ability, or lack of ability. The research of the reactions of schools in Massachusetts and California is ambiguous due to three questions that are addressed by those who support and those who oppose tracking in our classrooms. The following questions appear to be the center of change within schools; whether the change is due to location, populations, curriculum, or methods.

- How will the change affect student achievement?
- How will the change affect equity in the classroom?
- How will not changing affect our students if we choose not to change our teaching style or classroom structure?

Research appears to only support the advantages for high-track membership. The achievement gap is greater between students who choose to continue their education than those who do not (Loveless, 1998). Continuing education may be addressed to an economic situation as well as creating greater gaps due to the financial ability to attend school. Tracking differs from school to school as well as by subject matter. A high track class in one school may be the equivalent of a low-achieving class in another school (Loveless, 1998). Students react differently to tracking based on the subject. Mathematics appears to be the subject where the strongest

argument to maintain tracking is evident (Loveless, 1998) because, numerous educators feel mathematical concepts must be mastered for students to move onto the next degree of difficulty. A common example is to place educationally strong students “on track” for college in advanced-preparatory courses while placing all other students in general mathematics course or not requiring them to complete any additional mathematics curriculum. Very little evidence has been noted that there is any major impact from skill grouping (Loveless, 1998). “The evidence shows, that skill grouping has major impact, either positive or negative; on students’ cognitive learning...weak effects are because track differences in instruction are small” (pg 15).

A school which was required to place all students within their system heterogeneously dissolving the tracked classrooms fought back. The educators began switching students when they made the decision that the mixed ability classroom wasn’t working. Prior to this students had been tested. These scores were compared with the scores following the switch at the end of the semester. The results were quite interesting; the lower students had not moved academically during the semester. Further comparison of these lower students when they were immersed in a mixed ability class during their fifth and sixth grade years showed they had developmentally increased at an average level of growth opposite of what was shown by being tracked by their teachers. The failure of the tracking reform was due to the mathematics department’s resistance to the work ahead of them (Loveless, 1998).

Burris and Garrity (2008) took on an adventure transforming their district, detracking reform. The task with which they were challenged was to remove the ability grouping component from their classrooms. In their discussions, they noted that language was a hurdle that had to be cleared, because it shaped staff members’ perceptions regarding the education of students. The

phrase “student ability” was discarded and replaced with “student achievement.” The changes in terminology left doors open for students to grow through the use of the term achievement versus the term ability, which assumed they had met their growth level. In the study of their district, they found that students tended to track downward instead of upward. Burris and Garity also found that in assessing students for track placement their scores overlapped, “tracking does not create classes in which students are alike” (2008, p. 23).

Mathematics classrooms continue to work through the educational practice of tracking students, which is labeled as ability grouping. Students are placed in groups determined by their prior success within the mathematics classroom. Ability grouping is not consistent with the mandated goals as prescribed by the United States educational system. Ability grouping creates unequal opportunities for student educational achievement (Caldwell, 2002). “If this is true, and many educators believe it is, then we have no choice but to examine our grouping practices at both the elementary and secondary levels” (Hallinan, 1984, pp.238-239). Ability grouping has been a common topic of discussion among educators attempting to create the greatest success within their classrooms. Evers, Izumi, and Riley (2001) found a common myth among educators regarding the topic of ability grouping and discrimination. They state ability grouping inevitably discriminates against racial and ethnic minority students; educators should step away from standardized data as the source of grouping students (Evers, Izumi, & Riley, 2001). Students must be evaluated on comprehensive criteria. Socialization, leadership skills, behavior, as well as approach to challenging and complex concepts should all be considered as an educators process to group students to achieve the greatest growth.

Fiedler, Lange, and Winebrenner (2002) also discuss myths associated with ability

grouping; however, their research considers the gifted student population. Ability grouping should not lock students into a situation that does not allow them to be challenged. Differentiated curriculum and instruction should still remain a part of the gifted students' educational practice to ensure that all students are challenged appropriately.

Elitist attitudes can arise in a heterogeneous group unless gifted students are placed in situations where they are challenged by intellectual peers. Learners need to develop a realistic measurement of their abilities, as it is appropriate when they are measured among their peers. A realistic measurement of ability for students can be clouded by their perception of their personal strengths and weaknesses. Educator's choice of words can directly affect the students' personal perception of their ability to achieve. Cluster grouping allows individual students the opportunity to grow to their fullest potential allowing new students to rise to the top whereas ability grouping is an elitist mentality. Ability grouping only allows the group to grow as a whole. Classrooms within our school systems are a diverse collection of ability. How do educators address the needs of all students? For years, educators have been challenged with this question. Madeline Hunter's model (Hunter, 1982) suggests cooperative learning, which is based on Piaget and Vygotsky's research that social interaction opens doors for strengthening learning, through challenging assignments (Hunter, 1982). Cooperative learning allows a wide variety of student views, styles, interests, and talents to achieve a deeper understanding of the activity or problem proposed. Howard Gardner also proposed his theory in reaching the needs of all students "entry points," as described by his theory of multiple intelligences. The theory gives an educator a recipe for helping students learn a new topic. Gardner believes if narrative, logical, foundational, aesthetic, and experiential intelligences are used, then the end result will be differentiated classrooms with high levels of

student discussion and interaction with less work on the instructor's part (Gardner, 1991).

Tomlinson states that educators must be aware of the wide variety of students in a group, there is no substitute for high quality curriculum and instruction and we must build bridges between the student and their active role of learning (Tomlinson, 2005).

Research in meeting the diverse needs of all students continues through the discussion of the two types of classroom grouping, heterogeneous and homogeneous ability grouping. Within these two classroom groups, instructional options were also reviewed. The earliest form of instruction is where the educator is the deliverer of information. This is quite different from the concept of differentiation where the educators become the facilitators. The data available regarding ability grouping, tracking, and homogenous grouping all confirm that an increase in students' test scores has not evolved. To clarify, research suggests that heterogeneous and homogenous grouping does not include assessment scores (Ellis, Ellis, Huemann, & Stolarik, 2007).

Tomlinson strongly states that differentiated instruction is not the individualized instruction of the 1970s. It is not chaotic, and not a new way to provide homogenous grouping; she states that differentiated instruction is proactive, qualitative, rooted in assessment and provides multiple approaches. Differentiated instruction must be built on early understandings. Students must be encouraged to take upon themselves responsibility for their growth. Students who share the responsibility of educating themselves allow the educator to work with several different groups or students within a period. "In a differentiated classroom, the teacher proactively plans and carries out varied approaches to content, process, and product in anticipation of response to student differences in readiness, interest, and learning needs" (Tomlinson, 2001).

DIFFERENTIATED INSTRUCTION; STRATEGIES, SUGGESTIONS AND GUIDELINES

Reed (2004) defines differentiated lessons to include direct instruction, small group sessions, open-ended questions, and an assessment process. Reed continues that the differentiated instruction is based on instructional elements that grow positive learning environments. Brain based research, learning styles, multiple intelligences and authentic assessments all play roles in the skilled educator's use of differentiated instruction. Teachers who understand how each student demonstrates their ability are able to meet their individual learning style and create an opportunity for the student to demonstrate their true abilities. A variety of teaching styles will allow the educator to reach the students based on their individualized, intellectual capacity (HDI, 2011).

Instructors differentiate mathematics instruction based on the students' readiness level. Strategies used to meet the needs of the students' include tiered assignments, compacting, interest centers or interest groups, flexible grouping, learning contracts and choice boards. The differentiated lesson must also incorporate the categories: content, process, and product with key modifications. These modifications were:

1. Develop content with depth and complexity.
2. Encourage students to discover and search out solutions.
3. Provide open ended questions that required searching for answers from all angles and allow the mathematics to incorporate other departments, language arts, history etc.

Heterogeneous, as well as homogeneous grouping have concerns among educator.

Homogeneous ability groups within curriculums did not result in the achievements that had been expected. Researchers are finding that the homogenous ability group setting is actually widening the gap in student achievement. Students who were placed in heterogeneous mixed-ability settings had very positive results. Average and weak students showed noticeable growth, while stronger students showed little, adverse affects in educational growth (Lincheveski & Kutscher, 1998). The peer tutoring results were encouraging (Mastropieri, et al., 2006). A majority of the teachers involved reported the project did increase academic performance. Students were successful working with each other, completing critical content material. Growth rate accelerated in inclusive classrooms compared to more traditional classrooms. The Mastropieri study concluded that differentiated hands-on curriculum was a successful means of curriculum for all students, and the use of differentiated curriculum enhancements should be considered with peer mediation in other subject and grade areas.

Often, lower achieving students misplaced in high track classes showed greater growth, therefore, resulting in conclusions that were unexpected within the heterogeneous ability grouped classroom setting. Since the early 2000's, educational reform has encouraged instructors to move away from grouping or tracking students. Rather, students should be placed in a cohesive classroom setting. Caldwell (2002) advocates that effective grouping for students will allow them to build relationships that contribute to the strengthening of their learning process rather than the rejected or defeated feelings non-effective grouping can create. A group should not define who they are intellectually. Students already know where they fit in the scheme of their peers, and a daily reminder can be the catalyst for defeat, disruption, and discipline issues (Caldwell, 2002). Grouping patterns should be flexible based on the activity, the required result, and the purpose of

the group, size, and materials. These groups should be experimental and temporary based on interest, cooperation, and tutoring groups. Large groups may be used to build community while small groups allow more individualized attention. Groups should allow students to meet, discuss, discover and tutor each other through a variety of situations.

Students meet their educational challenges in varied degrees of complexity and types of critical thinking. “The elaborate pruning process we see in the brain during childhood makes it nearly statistically impossible for any two brains to match. The plasticity of the brain, the tremendous flexibility in what functions get put where, and how many neurons get dedicated to particular tasks, gives physical proof of the need for a variety of teaching strategies” (Nunley, 2006, pg xviii).

Gifted students meet their challenges within the cohesive classroom setting in a variety of ways. The review discussed that gifted students perform quite well and took into account the students growth and achievement. The study concluded gifted students will make it on their own; grouping them by ability does not result in improved learning or achievement for them. “Gifted students benefit cognitively and effectively from working with other gifted students...grouping of gifted and talented students in special classes with a differentiated curriculum, or as a cluster group in a regular heterogeneous classroom (but again with differentiated curriculum and instruction), leads to higher academic achievement and better academic attitudes for the gifted and leads to no decline in achievement or attitudes for the children who remain in the regular heterogeneous classroom” (Evers, Izumi, & Riley, 2001, p. 91). However, the heterogeneous classroom is not the only choice educators and administrators have used in their pursuit of educating all students. The discussion of students and ability grouped classrooms must be addressed within this discussion, as

it occurs within our educational system more so in the secondary grades. Madeline Hunter's model suggests cooperative learning, which is based on Piaget and Vygotsky's research that social interaction opens doors for strengthening learning, through challenging assignments. Cooperative learning allows a wide variety of student views, styles, interest, and talents to achieve a deeper understanding of the activity or problem proposed (Hunter, 1982).

Standardized testing creates its own issues, because educators are forced to turn their focus to teaching only tested material. This causes shallowness in education and boredom within the classrooms, especially among the gifted students. Heacox addresses this concern: "all students at some point will need differentiated instruction based on their particular and specific learning needs" (2008, pg 3). Heacox's list includes critical elements of differentiation, tiered assignments, discussion, and criteria for well-designed tiered lessons. Multiple avenues must be investigated and created to ensure not only struggling learners maximize growth but also advanced learners experience growth. Successful differentiated learning addresses academic diversity as well as equity (Tomlinson, 2005).

Cooperative learning does require the educator to steer away from ability group programs. Educators must be cautious within the heterogeneously grouped cooperative learning experience as teachers can be easily tempted to use gifted students as tutors rather than challenging these students and allowing them to learn through their own struggles (Evers, Izumi, & Riley, 2001). The cooperative learning experience is most effective for serving all students, including the gifted.

Jorgenson and Murray stated, developing learning communities within the classroom can set the class on the route to success with careful attention to all the elements of differentiated mathematics programs. Educators can do this by setting expectations, norms for classroom conduct

and successful outcomes will be achieved by all learners. Frameworks for differentiating, reflection, follow-up planning and responsive teaching will guide the educator through careful planning and will fulfill the goal of reaching all learners (Jorgenson & Murray, 2007).

Murray goes on to summarize in their opinion the characteristics of differentiated instruction to be:

- responsive teaching
- an organized and flexible approach using a wide collection of strategies
- adapting teaching and learning processes to reflect the different ways students learn
- students are challenged and supported in their approach to mathematical knowledge
- a problem solving environment is maintained
- students are given every opportunity to reach their full potential mathematically through the set of high standards and independent learning (2007).

Direct instruction, inquiry based learning, cooperative learning, and information processing strategies are used based on the needs of the students. No single teaching style will work for all students on mathematical topics. Once an instructional strategy has been chosen the educator must decide on a variety of instructional activities, and a means to assess or evaluate the students' progress.

Instructional strategies that engage students, further their knowledge helping them to apply their knowledge in ways that make sense will make the task at hand relevant to students, thereby

encouraging growth. A wide variety of assessment techniques such as portfolios, performance based assessments and projects will affirm the students’ understanding of the required material necessary to show the desired proficiency level (HDI, 2011). Assessments may be formal or informal. Murray compiled a list which he deems is a partial list of flexible assessments that will bend but not break the strength of assessment.

Graphic organizers	Reports	Demonstrations
Journals	Writing prompts	Skill performances
Portfolios	Projects	Tests
Pop quizzes	Checklists	Rubrics
Likert scales	Response cards	Exit slips
Hand signals	Observations	Interviews
Manipulatives	Student choice	Inventories
Sketches	Puzzles	Simulations
Posters	Role-playing and drama	Diaries
Logs	Contracts	Partner quizzes
Jigsaw quizzes		

Table 1 Flexible Student Assessments

(Jorgenson & Murray, 2007, p. 95)

Instructional strategies according to Gardner (1993) should be based on the multiple intelligences he discusses in his research. The seven intelligences are linguistic, logical, spatial, musical, interpersonal, and intrapersonal and correlative. These multiple intelligences work together for individuals to solve problems. Gardner believes it is the schools duty to develop these intelligences to allow students to reach career and personal goals that are based on their unique intelligences. Two assumptions he proposes are that everyone cannot learn everything and we all have interests and abilities unique to each of us. These assumptions are his foundation of the “utopian” education structure. “It is of the utmost importance that we recognize and nurture all of

the varied human intelligences, and all of the combinations of intelligences. If we recognize this, I think we will have at least a better chance of dealing appropriately with the many problems that we face in the world (Gardner, 1993)

Martin (2006) continues the discussion of addressing the diverse ways students learn and the styles that they learn to create a relaxed learning environment. He discusses Howard Gardner's seven intelligences as the framework of the lesson adaptations he features in his writing (Gardner, 1993). Through the use of Gardner's intelligences Martin includes respectful tasks, flexible grouping, and ongoing assessment. The discussion also includes essential and higher level thinking skills in the forefront while maintaining equitability, student interest, and readiness and learning styles making the necessary adaptations to maximize learning potential and success.

Strategies some educators use to differentiate the learning environment, while considering the students' readiness level and motivation to the learning process include:

- Tiered assignments
 - These address levels of complexity, abstractness, and open ended questioning. Compacting assesses the students' mastery level of previous concepts, moving the student toward new goals and enriching or accelerating the students' study to encourage growth and exploration.
- Interest centers or groups with flexible grouping
 - These allow the student to either interact with students at a predetermined mastery level or with students of similar interests.
- Learning contracts

- These allow an agreement to be reached between the teacher and the student as to what must be learned, and how this level of learning will be achieved.
- Choice boards
 - These allow for students to have a personalized choice in their education.

All of these teaching strategies use visual, auditory, kinesthetic and tactile activities to motivate the learning process.

Tomlinson created a framework to guide teachers as they begin building the differentiated classroom lesson plan by lesson plan (Tomlinson, 2003).

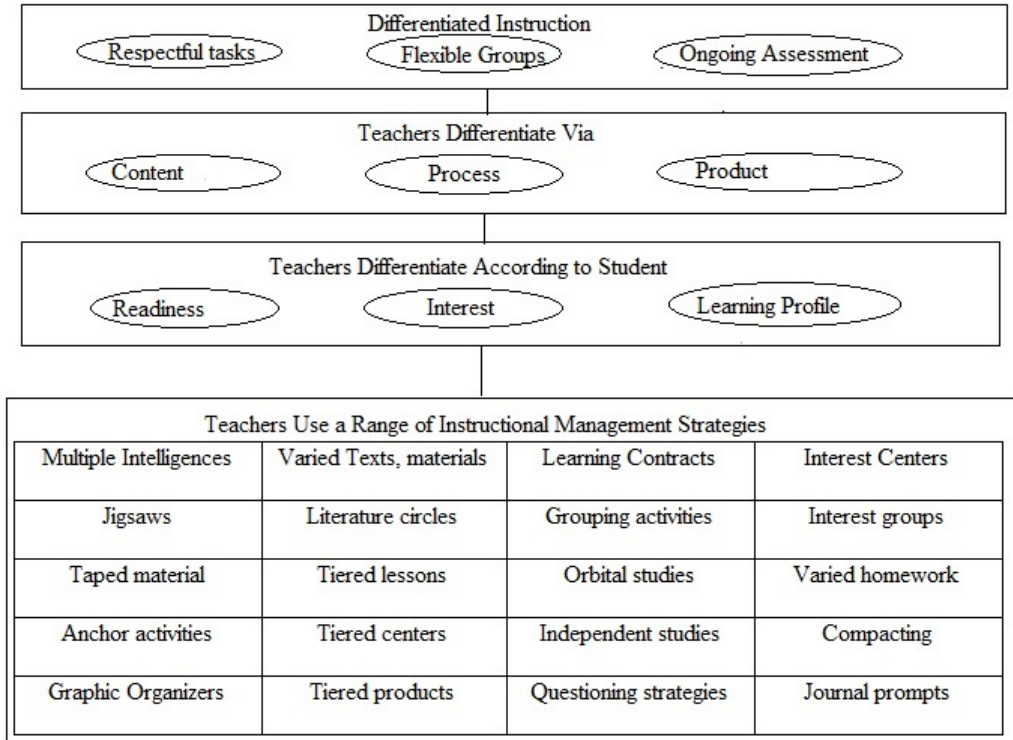


Figure 1 Differentiated Instruction Framework

Tiered lesson plans are a part of differentiation. Lessons can be tiered by readiness or by interest or learning profiles (Tomlinson, 1999).

Differentiated strategies:

- Anchors-activities to be completed alone by individual students at the beginning of class or when there is time. These are not time-fillers but meaningful self-directed strategies.
- Agendas-specific activities assigned to a particular student based on his or her personal educational needs to ensure proficiency in the concept being addressed. Agendas develop skills to ensure the ability of homework assignments (Moeller, 2007).

Teachers must learn how to differentiate the levels of demand. Brown (2004) advises task-sorting activities. Task sorting allows the teacher to understand the connection between the task and the type or kind of thinking the task required to complete.

TASK	LEVEL OF COGNITIVE DEMAND	EXPLANATION OF CATEGORIZATION	FEATURES
A	Doing Mathematics	No pathway is suggested by the task.	Is nonalgorithmic
		The Task Requires students to access relevant knowledge and experiences.	May use a calculator
		The task may involve some level of anxiety for the student.	
C	Memorization	The task involves reproducing previously learned definitions.	Is textbook like
		The task has no connection to concepts or meanings.	
E	Procedures with Connections	The task focuses students' attention on the use of procedures to develop deeper levels of understanding	Has real-world context, Is textbook like

		Procedures cannot be followed mindlessly	Involves multiple steps, may use a graphing calculator
F	Procedures without connections	Little ambiguity exists for what needs to be done.	Is textbook like
		The task requires no connection to meaning	Requires and explanation
		The task focuses the student on getting the right answer	Uses a diagram
		The task requires an explanation that focuses solely on describing the procedure used	May use a calculator
G	Procedures without connections	The use of a procedure is specifically called for	Is textbook like
		The task has no connection to underlying mathematics	Has real world context
		The focus is on obtaining the correct answer	Involves multiple steps
J	Doing Mathematics	No pathway is suggested by the task	Involves Multiple steps
		The task requires students to access relevant knowledge and experiences.	Requires an explanation
		The task requires nonalgorithmic thinking	Has real-world context
K	Memorization	The task involves reproducing previously learned rules and exact reproduction of previously learned terms.	Is textbook like and symbolic or abstract
L	Procedures with connections	The task focuses on using procedures to build deeper understanding.	Uses multiple representations
		The task requires the use of multiple representations	Involves multiple steps
		Procedures cannot be followed mindlessly	May use a calculator

Table 2 Cognitive Demand of Eight Sample Tasks (High School)

Educators must match the student achievement level, end goal, and successful learning strategy to make the mathematics meaningful on an individual level. Using data from interest

based surveys, academic data, and state and district assessments will allow the educator to choose appropriate differentiated instruction strategies to allow students to achieve their individual academic goals (Brown, 2004).

Murray(2007) states that teachers incorporating student characteristics when differentiating lessons find the characteristics useful in planning instructional decisions and lesson plans. Knowledge of student characteristics allow educators to create effective lesson plans for the entire class and adapt lesson elements reflecting individual student needs. Focused and engaged students have a higher probability of understanding mathematical depth. Students are encouraged to take control and responsibility for their mathematical learning.

Student Characteristics	Source(s) of Information
Talents, interests, ways of learning, strengths, goals	Student self-reporting, parents, records, former teachers, inventory observation, math autobiography, professional reading
Cognitive Profile Language; oral, written, and mathematical Thinking and reasoning Content strand skills: number, geometry, measurement, etc. Conceptual needs and strengths Estimation and problem-solving skills	Records, former teachers, mathematics survey, math autobiography, observations, pre-assessments
Emotional Characteristics: Motivation, responsibility, persistence, anxieties Physical conditions: preferences and needs Social relationships: peer and adult Work environment preferences and needs: Distractibility, individual/group, competitive/collaborative Language, cultural background, worldview	Parents, former teachers, observation, records
Intellectual issues and exceptional needs Math experiences, attitudes, and learning dispositions	Records, Former Teachers, observations, records
Learning preferences Auditory, visual and or kinesthetic	Professional reading, inventories, former teachers, observation

Silver and Strong mathematics, learning styles Human Dynamics Gardner: Multiple Intelligences	
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Table 3 Student Characteristics and Sources

(Jorgenson & Murray, 2007, p. 55)

After considering the list of student characteristics and using the research from Howard Gardner’s multiple intelligences, educators can implement a plan that will embrace all learners (Gardner, 1991). A reflection tool to accommodate learning styles of students was earlier created by the Elementary Task Force of the San Diego County Office of Education. The modified list helps assure a platform to support complex accommodations for students’ needs.

Give students opportunities to:	
Make choices	Study Independently
Use visual materials	Listen to audio materials
Listen to lectures	Work at his or her own level
Study Quietly	Work at his or her own speed
Study in Groups	Correct Failures/errors
Present oral responses	Learn by doing
Present written responses	Clarify Information
Create projects	Take oral assessments
Engage in discussion	Take written Assessments
Share in planning	Be creative

Table 4 Partial Student Accommodation List

(Jorgenson & Murray, 2007, p. 72)

Small (2010) discusses two techniques to use in the differentiated classroom instruction: open questions and parallel tasks. The open question must be broad enough so as to allow all students to be involved no matter what the ability level of the student. Parallel tasks allow the focus of one large idea while the investigation of different levels of complexity and understanding are

carried out. Small continues by addressing a trend that is running through much of the literature, a fear that teachers deal with: how to manage and plan the differentiated lessons. Mathematical opportunities for our students must encourage students to think conceptually while stimulating connections to allow students to work toward other mathematical concepts and problems.

Teaching students to work for high quality is a challenge for all educators. The five strands of mathematical proficiency define what is not flexible within the framework of differentiated lessons (Murray, 2010). The strands of proficiency; understanding, computing, applying, reasoning and engaging create high expectations for all learners and are not flexible. Educators may use group learning processes, timing product outcomes, varying assessment tools, and lesson design to create the flexibility that differentiated lessons require (Jorgenson & Murray, 2007).

Tasks that are well defined without assumed options can lead the quality piece of work educators are seeking. Educators who patiently and persistently insist on work that is based on standards of excellence, and only high quality student work is accepted, will find students reach for the bar if the requirements are explained and obtainable. Benjamin states “differentiated instruction is a practice that grows out of certain values” (2006, pg 57). The values she lists are: meaningful choice, learning how to learn, variety in assessment, collegiality, student talk and open-endedness, and the role of an educator.

There were pitfalls and setbacks just as there are with any change of habit (Burriss & Garrity, 2008). Educators were warned to be cautious of in-class tracking. This concern was resolved by students completing initial work on their own, and then sharing their work within their group. Individual accountability and off-task students can be addressed using this model of student centered constructivist lessons within the differentiated classroom. Educators must constantly

review their past, present, and future teaching practices. Questions of self-reflection will assist them in lesson plans. Are the learning objective and curriculum linked? Is the construction of knowledge clear? Do students have ample time to practice, process, question, and show what they know? Is everyone's voice heard in the discussions? Is the lesson differentiated to allow for each student to be successful?

Demographics are directly correlated to the educational value families place on the education process. This, they felt, added to the problem of accommodating not only day-to-day educational issues, but also created other challenges caused by the home situation; latch key children, transiency, financial issues in the home, and single parents, all left little time for parental support in the educational process. Students needed to feel that the educational process was important. To build this educational self-esteem, students were polled regarding their interests and learning styles. For their project to be successful, the researchers chose to modify instruction, content, process, and the students' work or product. Researchers followed and monitored the process through continuous assessment and individual success and progress (Nunley, 2006).

The challenge for all educators is how to differentiate their lesson plans on a daily basis. A mold, a chart, or a computer program to create the lesson plans for each student and guarantee success would be every teacher's wish. Educators who approach teaching as an art and choose to research, examine, change, and mold the differentiated classroom are in tune with their students and create success for their students and their classes. Adapting lessons through curriculum elements may involve differentiating one or more elements that begin with, but are not limited to, content, process, and product (Tomlinson, 1999). A recipe to address all these teacher related concerns surrounding differentiated classroom techniques would be welcomed by many educators.

However, there is no outline or steps for the differentiated lesson plan. Ellis *et al* (2007) provide several guidelines to consider.

- The grading system and lessons will need to be adjusted as well as the lessons in a differentiated classroom.
- Students must be kept actively engaged and interested.
- Adaption of lessons required to meet the various levels of the learners.
- Planning time is necessary and must be allowed.
- Successful lessons are engaging and accessible but not watered down.
- Lessons must have the obstacles identified.
- Students need time to work and learn cooperatively.
- Students must be facilitated and encouraged to gain knowledge through the strengths of their interests.
- Pre-assessing was discontinued however Ellis and his researchers retained post-assessing as a vital component to the success of the differentiated classroom
- Multi-level instruction is necessary as well as multi-level tasks.
- The special education student must be addressed within this differentiated classroom setting. Success for special education students was noticed when the students' classroom structure involved a half-way class, or a learning lab. A special education student should have one-on-one assistance within the class (Ellis et al 2007).

STUDIES AND IMPLEMENTATION OF DIFFERENTIATED INSTRUCTION

A group of instructional educators with expertise from kindergarten through high school embarked on a research project to gather data to support the idea of differentiated instruction. The basis of the research conducted was improving mathematical skills for 79 math students, 26 of whom were in grades 10-12. One way to accommodate the many levels of these students, as discussed in this paper, was differentiating instruction. One of these educators was a high school educator from an upper middle class suburb of Chicago. The researchers found data that supported their hypothesis that demographics are directly correlated to the educational value families place on the education process. This, they felt, added to the problem of accommodating not only day-to-day educational issues, but also created other challenges caused by the home situation; latch key children, frequent moves, financial issues in the home, and single parents, all left little time for parental support in the educational process. Students needed to feel that the educational process was important. To build this educational self-esteem, students were polled regarding their interests and learning styles. For their project to be successful, the researchers chose to modify instruction, content, process, and the students' work or product. Researchers followed and monitored the process through continuous assessment and individual success and progress (Nunley, 2006).

The results of their research from the earlier mentioned group of educators and students found the following:

- Differentiation may meet the needs of students on multiple levels.
- Teachers are frustrated with mixed-ability classrooms and feel differentiation may

be the answer.

- Students require different amounts of time to complete tasks.
- High school students prefer working in groups.
- High school students prefer a small group or one-on-one if they are struggling.
- High school students prefer to solve problems rather than write about the problems.
- Students prefer worksheets to textbook work.
- Students prefer manipulatives and games.
- Teachers concur with the results and agree to create cooperative lessons where students will have choices and manipulatives (Ellis et al, 2007).

With these polled results, educators were then challenged to incorporate the results within their differentiated lesson plans.

Reed's study included 22 teachers instructing 17 heterogeneously grouped geometry classes capped at 32 students. It concluded that "Mathematically promising students are defined as those who have the potential to become the leaders and problem solvers of the future" (Reed, 2004, p. 90). Reed further discusses opportunities within the differentiation process. "Three differentiation opportunities are presented and discussed. The first opportunity is an extension and application of current class work. The second is an investigation of open-ended questions. The third is a consideration of student-selected problems. Each provides content, process and differentiation" (Reed, 2004, p. 89). The question is basically the same; at what level should educators teach to match ability with curriculum and scaffolding on prior knowledge? The gifted student with merging promise or high ability can be possibly split into at least two types: the

precocious student that is able to do mathematics beyond their grade level, and the student who is able to do deep, demanding problems by calling on their entire toolbox of problem-solving abilities to build toward the correct solutions. Reed found that gifted students, as well as the entire class, benefited from the differentiated lessons (2004).

Fairness in the classroom is a concern for the differentiated lesson as fairness of students' assignments is confused with assignment modifications. Nunley makes the cases that if teachers modify an assignment for one student why not modify the assignment for the whole class (2006)? A multilevel assignment strategy for students allows complex assignments for higher-ability students with a larger point value and several smaller point assignments for the lower-ability and/or struggling students. Fairness of such an assignment grid can be argued. Is it fair that the lower-ability student must complete more problems? Nunley states that it is acceptable for lower students to work harder and longer on the problems that cause difficulty. It is important that these problems are reasonable but not beneath their obtainable ability. All students should be encouraged to ask for extended time to complete assignments due to extenuating situations. However, time frame must be agreed upon. Students also need to be made aware that the teacher is willing and available to assist with problems and struggles (Nunley, 2006).

As a school district adopted the heterogeneous classroom setting, Burriss and Garrity (2008) reported that this began an adventurous endeavor for the district to begin the detracking setting of its students. The adventure involved a committee of ten elementary teachers and nine middle school math teachers, Delia Garrity, author as well as administration from the Rockville Center district of New York. Educators began with Bloom's taxonomy levels, process and product rubrics. The district established core beliefs, mandates, highly examining resources, and discussions to

create a district template. Classroom curriculum that explored, extended, and included hands on practices was adopted. Students of multiple intelligences were integrated into the units of differentiated content. They adopted the motto “it is not what you teach, but how you teach” (Burris & Garrity, 2008, p. 94). The district modeled three lessons infusing differentiation by intelligences, differentiation by achievement levels, and differentiation by assessment during an educators’ workshop to assist the staff in achieving the district wide goal to detrack students.

In a different district the detracked classroom mandate was placed on educators, and a different result occurred. A curriculum centered on construction and investigation has been shown not to require this hierarchy of concepts (Loveless, 1998). The role of the middle school creates conflicts for the high schools. Conflicts occurred due to non-tracking and the lesson plans written to differentiate concepts for students. Middle school teachers were instructed to detrack their classrooms; however, as state curriculum mandates are placed on these mathematics classrooms, teachers find it harder to keep their classrooms detracked as they push to meet state standards (Loveless, 1998). Hillcrest Middle School was required to place all students within their system to dissolve the heterogeneously tracked classrooms, educators fought back. The educators began switching students when they made the decision that the mixed-ability classrooms were not working. Prior to this, students had been tested, and these scores were compared with the scores following the student switch at the end of the semester. The assessment results were interesting; the lower students had not changed academically during the semester following the switch. Further comparison of the lower students involved in the mixed ability class during their fifth and sixth grade years; concluded the students’ assessment results increased at an average level of growth. This assessment conclusion was a contradiction of the result found following the switch by the

educators to ability grouped setting (Loveless, 1998).

Research by Tomlinson shows the differentiated, heterogeneous mathematics classroom develops greater student academic success (1999). For this success to happen, differentiation must be based on a student's readiness, interest, and learning profile, as well as curricular elements content, process, and products. Effective lesson plans of a differentiated classroom use a mix of whole-class, differentiated, and non differentiated lesson pieces. It is only necessary to differentiate when a student's need arises, and by modifying the lesson, the educator can acquire a greater level of learning. An educator does not create a level of respect by ignoring a student's level of learning. Deep respect for a student's identity is what makes a classroom work. "Respect the readiness level of each student. Expect all students to grow, and support their continual growth. Offer all students the opportunity to explore essential understandings and skills at degrees of difficulty that escalate consistently as they develop their understanding and skill. Offer all students tasks that look intriguing and are equally interesting, important, and engaging" (Tomlinson, 1999, p. 12).

An alternate approach to differentiating the classroom was reported by Mastropieri et al. (2006). This study was based on the inclusion of special education students within the science classroom. The nine-week study was done with eighth grade students. These students were matched with a peer tutor who was responsible for tutoring the major concepts of the unit being addressed. These tutors were given material to use as needed, hence differentiating the unit within the general tutoring. The units were taught in a sequential order with levels of instruction matching the special education students' needs. Students demonstrating mastery were given differentiated options that matched the unit for the entire class. Differentiation will not always be the answer on a daily or task by task basis (2006). Educators are challenged to meet the needs of students with an

arsenal of differentiated instruction plans. The greatest challenge is how to meet the needs of every student when introducing challenging material. Teachers had difficulty finding time to incorporate the experimental material, as they were under pressure to ensure the high-stakes testing content material was securely in place. This left little room for experimental material. Whatever the level of difficulty, the investigation did show positive results concerning the peer tutoring within the classroom content, as well as the end-of-year tests (Mastropieri et al, 2006).

A lecture-based classroom, according to Nunley (2006), is composed of three categories of students: attentive, fidgety, and non-listeners.

- Attentive listeners are successful in the lecture classroom; these students prefer this type of classroom and will probably perform well in high school as well as college.
- Fidgety listeners are students who will multitask during a lecture based class; they will clean out a backpack, doodle, and grasp some of the information given.
- Non-listeners are the students who either cannot or refuse to engage in the learning process. Here is where a majority of the discipline problems and power struggles arise within the classroom.

Reaching all students equitably, using differentiated instructing was not without stumbling blocks.

Tomlinson noted that educators challenged with throwing out the way they have been teaching and embracing change find themselves facing many hurdles. Some teachers have to learn a new method of teaching; all teachers must find time in a schedule that has no room for hours of lesson planning to incorporate new methods. “It is so easy to underestimate the complexities of the change process....Change is difficult because it is riddled with dilemmas, ambivalences, and

paradoxes. It combines steps that do not seem to go together: to have a clear vision and be open minded; to take initiative and empower others; to provide support and pressure; to start small and think big; to expect results and be patient and persistent; to have a plan and be flexible; to use top-down and bottom-up strategies; and to experience uncertainty and satisfaction” (Tomlinson, 1990, pg 108). In a later publication, Tomlinson (2003) states that educators must embrace the concept and differentiation must become a way of life for the educator as well as the student. Effective differentiation is driven by educators embracing that each student is not a standard student. Differentiation does not allow a substitute for high-quality curriculum however; we must also build connections between students and learning.

CONCLUSION

Nordlund (2003) continues with words of direction for instructors and the task ahead. She begins her discussion on differentiated instruction with a caution to teachers of the task ahead of them and to keep the purpose of instruction in focus. She leads the reader by basing the foundation of her discussion on Bloom’s Taxonomy. The process of disseminating the classroom and organizing the students’ needs and adaptations for success continues as she walks the educator through principles of learning strategies, students with learning disabilities, gifted and talented students, at risk students, and different teaching styles (Nordlund, 2003). Failure to complete the task of detracking a classroom can be blamed on resistance, to which Loveless (1998) refers. The failure of the reform from homogeneous to heterogeneous grouping was due to the mathematics

departments' resistance to the work educators had ahead of them. Hillcrest Middle school had a plan to ease the restructuring of their school to a heterogeneous grouping of students. The math teachers moved from three tracked or level of classes to two, eliminating the remedial group of students and incorporating them into the remaining two tracks. Math teachers were frustrated with the range of abilities. Teachers attempted to teach the two classes as they had taught the three levels before. The math teachers took action and started trading students to restore Homogenous classroom structures. This resistance by the math department was the initial step to the end of Hillcrest's attempt to detrack their students. The group that was assigned the task to implement this change, the advisory class, as well as administration was deeply resented; teachers filed grievances, as well as new school board members elected. Change or reform needs to be proposed in parts of manageable size and with the tools necessary to be successful. Detracking, which moves teachers toward differentiated lessons to create success at all levels, must come with the training and the resources to ensure manageability and success. Heterogeneous classrooms require more materials, especially hands on activities and group work. Teachers must be willing to grow and embrace the challenge; possibly requiring new methods classes to attack the change insuring the possibility of success. Materials of varying levels must be made available and students must be taught how to work together to ensure the success of all (Loveless, 1998). Managing the extreme ends of the classroom is the greatest challenge and threat to the success of a heterogeneously grouped classroom. Dissolving homogenous grouping in the classroom creates change for students as well as educators: lessons will need to be adapted, more oral reading will be required, and assignments will have to be varied. Such changes will assist the educator in producing a cohesive classroom setting.

The result of this research found students did improve with this education option (Ellis, 2007). However, the lack of success or cooperation was grounded with educators feeling inadequately trained and time constraints for lesson plans. Teachers began this project mid school year and it is believed by those involved that the frustrations felt by their fellow educators could be lessened with additional training and resources. They also decided to remove the pretest and use informal observation as means to monitor student progress. Researches feel with this continued effort they will continue to see student progress (Ellis, 2007).

Chapter 3: Synthesize Research

STAFF DEVELOPMENT

The earliest form of instruction is where the educator is the deliverer of information and with the concept of differentiation the educator must reevaluate their role. Educators become facilitators with differentiation. The data of ability grouping, tracking, and heterogeneous grouping did not show an increase in students' test scores during the study conducted by (Ellis et al 2007). Their conclusions of the data results were that teachers need to be immersed in training to assist them in this new role as facilitators. Teachers leave college aware that they must cover a certain amount of curriculum, make students pass standardized tests, and accomplish this with minimal training, support, and materials (Ellis et al 2007).

For teachers to change and reform, the requirements must be proposed in manageable proportions with the necessary tools to create success (Nordland, 2003). Training and resources need to be accessible by the educators charged with the task of differentiating a curriculum, or classroom to ensure manageability and success (Loveless, 1998). Educators must be reflective of their teaching practices and cautious of in-class tracking (Burris & Garity, 2008). The motto "it is not what you teach, but how you teach" adopted by the Rockville center district in New York guided the district model of differentiation by intelligences, achievement levels and assessment. The district goal was to non-track students (Burris & Garity, 2008, p. 94)

Mathematics classrooms continue to work through the educational practice of tracking/ability grouping of students. Evers, Izumi, and Riley (2001) found a common myth among educators regarding the topic of ability grouping and discrimination. They state ability grouping inevitably discriminates against racial and ethnic minority students; educators should step away from standardized data as the source of grouping students (Evers, Izumi, & Riley, 2001). Students must be evaluated on comprehensive criteria to allow mathematical proficiency.

The five strands of mathematical proficiency as proposed by Murray (Murray, 2010) understanding, computing, applying, reasoning and engaging lessons to create learners with high expectation through group processes, assessment tools and lesson design (Jorgenson & Murray, 2007). For teachers to learn a new method of teaching they need to allow time in a schedule to research and learn what is needed to be successful, change is difficult. Educators must have an open mind and empower their peers by providing support. Teachers starting small, expecting results, being patient and persistent as well as expecting uncertainty will find over time success (Tomlinson, 1990). Teachers have difficulty finding time to incorporate experimental material with high stakes testing content material leaving little time to develop new material (Mastropieri et al, 2006).

Brown (2004) offers task sorting activities to allow teachers to make connections between tasks and types or kinds of thinking.

TASK	LEVEL OF COGNITIVE DEMAND	EXPLANATION OF CATEGORIZATION	FEATURES
A	Doing Mathematics	No pathway is suggested by the task.	Is nonalgorithmic
		The Task Requires students to access relevant knowledge and experiences.	May use a calculator
		The task may involve some level of anxiety for the student.	
C	Memorization	The task involves reproducing previously learned definitions.	Is textbook like
		The task has no connection to concepts or meanings.	
E	Procedures with Connections	The task focuses students' attention on the use of procedures to develop deeper levels of understanding	Has real-world context, Is textbook like
		Procedures cannot be followed mindlessly	Involves multiple steps, may use a graphing calculator
F	Procedures without connections	Little ambiguity exists for what needs to be done.	Is textbook like
		The task requires no connection to meaning	Requires and explanation
		The task focuses the student on getting the right answer	Uses a diagram
		The task requires an explanation that focuses solely on describing the procedure used	May use a calculator
G	Procedures without connections	The use of a procedure is specifically called for	Is textbook like
		The task has no connection to underlying mathematics	Has real world context
		The focus is on obtaining the correct answer	Involves multiple steps
J	Doing Mathematics	No pathway is suggested by the task	Involves Multiple steps
		The task requires students to access relevant knowledge and experiences.	Requires an explanation
		The task requires nonalgorithmic thinking	Has real-world context

K	Memorization	The task involves reproducing previously learned rules and exact reproduction of previously learned terms.	Is textbook like and symbolic or abstract
L	Procedures with connections	The task focuses on using procedures to build deeper understanding.	Uses multiple representations
		The task requires the use of multiple representations	Involves multiple steps
		Procedures cannot be followed mindlessly	May use a calculator

Table 5 Cognitive Demand of Eight Sample Tasks (High School)

Teachers must learn how to differentiate the levels of demands, matching the student achievement level, end goal, and strategy to make the lesson meaningful on a personal individual level (Brown, 2004).

KNOWLEDGE BASE

Differentiated instruction is built on early understanding. Challenging tasks ask students to venture into the unknown, but they have the skills and support to begin the task building to a new level of understanding. This growth is necessary for students to remain engaged in the learning process. Consistently failing students give up, and students who always succeed, lose motivation. It is a new way to provide a non chaotic heterogeneous grouping rooted in assessment and multiple approaches (Tomlinson, 2001). Student characteristics and research from Howard Gardner's multiple intelligences are blocks to begin the construction of plans to embrace all learners (Gardner, 1991). Brain based research; multiple intelligences, learning styles and assessment allow

the educator to create lessons for the student to demonstrate their individual abilities based on their personal intellectual capacity (HDI, 2011).

Student ability can be clouded by their personal perception of their strengths and weaknesses. Language can also be a hurdle. Student ability can create a mindset different than student achievement. A change in terminology can open doors for students. Cluster and ability groups create a different mindset within the student. Cluster allows students to rise and fall within a group where ability gives the persona of an elitist group. Educators have many things to consider when establishing groups in the homogeneous classroom. A mindset among educators that can stall growth is the feeling that mathematical concepts must be mastered before student to move onto the next degree of difficulty (Loveless, 1998).

Heterogeneous, as well as homogeneous grouping have concerns among educators and homogeneous ability groups within curriculums did not result in the expected achievements (Mastropieri, et al., 2006). Researchers reported that the homogenous ability group setting is actually widening the gap in student achievement. Students who were placed in heterogeneous mixed-ability settings had very positive results. Average and weaker students showed noticeable growth, while stronger students showed little, adverse affects in educational growth (Lincheveski & Kutscher, 1998). The peer tutoring results were encouraging (Mastropieri, et al., 2006). A majority of the teachers involved reported the project did increase academic performance. Students were successful working with each other, completing critical content material. Growth rate accelerated in inclusive classrooms compared to more traditional classrooms. Mastropieri concluded that differentiated hands-on curriculum was a successful means of curriculum for all students, and the use of differentiated curriculum enhancements should be considered with peer

mediation in other subject and grade areas.

Beginning in the early 2000's, educational reform has encouraged instructors to move away from grouping or tracking students; rather, students should be placed in a cohesive classroom setting. Such placement often resulted in lower achieving students in high tracked classrooms showing greater growth (Caldwell, 2002). Hillcrest Middle School assessment results were interesting; the lower students had not changed academically during the semester following the switch. Further comparison of the lower students involved in the mixed ability class during their fifth and sixth grade years concluded the students' assessment results increased at an average level of growth. This assessment conclusion was a contradiction of the result found following the switch by the educators to ability grouped setting (Loveless, 1998) . Research by Tomlinson (1999) shows the differentiated, heterogeneous mathematics classroom develops greater student academic success. For this success to happen, differentiation must be based on a student's readiness, interest, and learning profile, as well as curricular elements content, process, and product. It is only necessary to differentiate when a student's need arises, and by modifying the lesson, the educator can acquire a greater level of learning.

Murray (2007) states that teachers incorporating student characteristics when differentiating lessons find the characteristics useful in planning instructional decisions and lesson plans. Knowledge of student characteristics allow educators to adapt lesson elements to reflect individual student needs and more effective planning for the entire class. Keeping students focused and engaged by educators creates a higher probability of creating and understanding mathematical depth. Students gain control and responsibility for their mathematical learning.

Student Characteristics	Source(s) of Information
Talents, interests, ways of learning, strengths, goals	Student self-reporting, parents, records, former teachers, inventory observation, math autobiography, professional reading
Cognitive Profile Language; oral, written, and mathematical Thinking and reasoning Content strand skills: number, geometry, measurement, etc. Conceptual needs and strengths Estimation and problem-solving skills	Records, former teachers, mathematics survey, math autobiography, observations, pre-assessments
Emotional Characteristics: Motivation, responsibility, persistence, anxieties Physical conditions: preferences and needs Social relationships: peer and adult Work environment preferences and needs: Distractibility, individual/group, competitive/collaborative Language, cultural background, worldview	Parents, former teachers, observation, records
Intellectual issues and exceptional needs Math experiences, attitudes, and learning dispositions	Records, Former Teachers, observations, records
Learning preferences Auditory, visual and or kinesthetic Silver and Strong mathematics, learning styles Human Dynamics Gardner: Multiple Intelligences	Professional reading, inventories, former teachers, observation

Table 6 Student Characteristics and Sources

(Jorgenson & Murray, 2007, p. 55)

Questions of self-reflection will assist teachers in lesson plans. Are the learning objective and curriculum linked? Is the construction of knowledge clear? Do students have ample time to practice, process, question, and show what they know? Is everyone’s voice heard in the discussions? Is the lesson differentiated to allow for each student to be successful (Burriss and Garity, 2008)?

Demographics are directly correlated to the educational value families place on the education process. This, they felt, added to the problem of accommodating not only day-to-day educational issues, but also created other challenges caused by the home situation; latch key children, transiency, financial issues in the home, and single parents, all left little time for parental support in the educational process. Students needed to feel that the educational process was important. To build this educational self-esteem, students were polled regarding their interests and learning styles. For their project to be successful, the researchers chose to modify instruction, content, process, and the students' work or product. Researchers followed and monitored the process through continuous assessment and individual success and progress (Nunley 2006).

GROUPING OPTIONS

Students already know where they fit in the scheme of their lessons. Grouping patterns should be flexible based on the activity, the required result, and the purpose of the group, size, and materials. These groups should be experimental and temporary based on interest, cooperative, and tutoring groups. Large groups may be used to build community while small groups allow more individualized attention. Groups should allow students to meet, discuss, discover and tutor each other through a variety of situations (Evers, Izumi, & Riley, 2001). Students who share the responsibility of educating themselves allow the educator to work with several different groups or students within a class period. "In a differentiated classroom, the teacher proactively plans and carries out varied approaches to content, process, and product in anticipation of response to student

differences in readiness, interest and learning needs”(Tomlinson, 2001). Interest centers with flexible grouping, allows the student to interact with peers of similar interests or mastery levels. “Tracking does not create classes in which students are alike” (Burriss & Garrity, 2008, pg 23). For years, educators have been challenged with how to address the needs of all students. Madeline Hunter’s model suggests cooperative learning, which is based on Piaget and Vygotsky’s research that social interaction opens doors for strengthening learning, through challenging assignments Cooperative learning allows a wide variety of student views, styles, interests, and talents to achieve a deeper understanding of the activity or problem proposed (Hunter, 1982).

Grouping creates concerns among educators. Homogenous ability groups within curriculums did not result in the achievements that had been expected (Evers, Izumi, & Riley, 2001). Researchers are finding that the homogenous ability group setting is actually widening the gap in student achievement. However, educators who were instructed to detrack their classrooms are struggling to keep classes detracted due to the mandates that are placed on them as educators to meet state standards (Loveless, 1998). In frustration at Hillcrest Middle School, educators made the decision mixed-ability classrooms were not working and switched students defying their orders to detrack their classrooms. Ability grouping has been a common topic of discussion among educators attempting to create the greatest success within their classrooms. Evers, Izumi, and Riley (2001) found a common myth among educators regarding the topic of ability grouping and discrimination. They state ability grouping inevitably discriminates against racial and ethnic minority students; educators should step away from standardized data as the source of grouping students (Evers, Izumi, & Riley, 2001).

Ability grouping should not lock students into a situation that does not allow them to be challenged. Differentiated curriculum and instructions should still remain a part of the gifted students' education practice to ensure that all students are challenged appropriately. A common myth among educators regarding the topic of ability grouping and discrimination stated that ability grouping inevitably discriminates against racial and ethnic minority students. Educators should refrain from using standardized data as the source of grouping students (Evers, Izumi, & Riley, 2001).

DIFFERENT STRATEGIES

A successful differentiated classroom teacher leads her students, involving them in the journey. The classroom is student-centered. The students drive the necessity of when a lesson must be differentiated and when it does not. There is no requirement for this to happen for everyone every day. Educators must select moments based on assessment both formal and informal. When the decision is made to differentiate a lesson, appropriate tasks must be chosen that are challenging. Challenging tasks ask students to venture into the unknown, but they have the skills and support to begin the task building to a new level of understanding. This growth is necessary for students to remain engaged in the learning process (Tomlinson, 1999). Tomlinson created a framework to guide teachers as they begin the differentiated classroom lesson plan (Preszler, 2006).

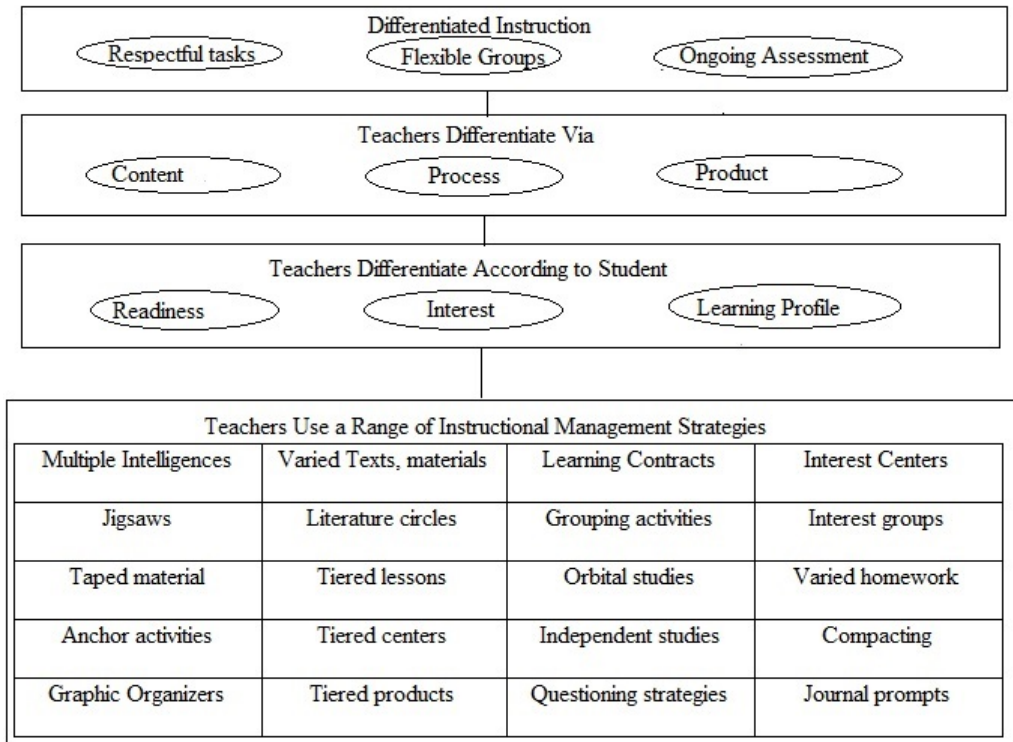


Figure 2 Differentiated Instruction Framework

Murray (2007) compiled a list of flexible assessments.

Graphic organizers	Reports	Demonstrations
Journals	Writing prompts	Skill performances
Portfolios	Projects	Tests
Pop quizzes	Checklists	Rubrics
Likert scales	Response cards	Exit slips
Hand signals	Observations	Interviews
Manipulatives	Student choice	Inventories
Sketches	Puzzles	Simulations
Posters	Role-playing and drama	Diaries
Logs	Contracts	Partner quizzes
Jigsaw quizzes		

Table 7 Flexible Student Assessments

Heterogeneous classrooms require more materials, especially hands on activities and group work. Students must be kept actively engaged and interested in the learning process which educators maintain through engaging and accessible lessons. Students prefer worksheets, manipulatives and games to textbook assignments. Give students opportunity to;

Make choices	Study Independently
Use visual materials	Listen to audio materials
Listen to lectures	Work at his or her own level
Study Quietly	Work at his or her own speed
Study in Groups	Correct Failures/errors
Present oral responses	Learn by doing
Present written responses	Clarify Information
Create projects	Take oral assessments
Engage in discussion	Take written Assessments
Share in planning	Be creative

Table 8 Partial Student Accommodation List

(Jorgenson & Murray, 2007, p. 72)

Tasks that are well defined without assumed options can lead the quality of work based on standards of excellence. Only high quality student work should be accepted which encourages students to reach for the bar with well explained and obtainable goals. “Differentiated instruction is a practice that grows out of certain values” (Benjamin, 2006, pg 57).

Reed (2004) states differentiated lessons may include direct instruction, small group sessions, open-ended questions, and an assessment process. The differentiated lesson must also incorporate the categories content, process, and product with key modifications. These modifications are:

1. Develop content with depth and complexity.
2. Encourage students to discover and search out solutions.

3. Provide open ended questions that required searching for answers from all angles and allow the mathematics to incorporate other departments, language arts, history etc.

Martin (2006) includes respectful tasks; flexible grouping and ongoing assessment are necessary to ensure learning potential and success. Tomlinson (1999) continues this thought pattern adding tasks must look intriguing, are equally extensive, and engaging. Other strategies to consider include interest centers or groups, projects that affirm student understanding and an opportunity to investigate open ended questions.

Agenda specific lessons or assessments, flexible groups, choice boards, anchor activities, pre assessment and learning contracts are all discussed options to consider when making choices regarding differentiated strategies (Tomlinson, 2005).

CLASSROOM MANAGEMENT

An educator does not create a level of respect by ignoring a student's level of learning. Deep respect for a student's identity is what makes a classroom work. Educators need to offer tasks that are equally important, engaging and interesting will build a respect of readiness with students. Students are expected to grow and work toward continual growth (Tomlinson, 1999).

The researchers found data that supported their hypothesis that demographics are directly correlated to the educational value families place on the education process. This they felt added to the problem of accommodating not only day to day educational issues, but created other challenges

caused by the home situation; latch key children, frequent moves, financial issues in the home, single parents, which left little time for parental support in the educational process. Students needed to feel that the educational process was important. To build this educational self esteem, students were polled regarding their interests and learning styles (Ellis et al, 2007) Our students are a diverse population, with diverse learning needs and requirements, which insures the need for differentiated instruction (Nunley, 2006). Nunley continues by noting the frustration of fidgety and non-listeners with in the classroom as well as the mixed ability classroom and feels that differentiation may be the answer for all learners and the attentive student as well. Students require different amounts of time to complete tasks, and high school students prefer working in groups. Educators meet these needs by challenging students while supporting their mathematical knowledge through a problem solving environment which can allow students to reach their mathematical potential while educators maintain high standards and encourage independent learning (Jorgenson and Murray, 2007) Teachers must be accessible and willing to assist with problems and struggles the student encounters (Nunley, 2006). Research and self examination with a willingness to adapt and change will keep educators in tune with their students needs and create success with in the differentiated classroom (Tomlinson, 1999).

Differentiated lessons cause a concern for teachers and students regarding fairness in the classroom (Nunley, 2006). Jorgenson and Murray (2007) found well thought-out learning communities with expectations and norms of conduct set the class on route to succeed. Peer tutoring within the classroom as well as yearend assessments resulted in positive results throughout the level of difficulty (Jorgenson &Murray, 2007).

Nunley (2006) makes the cases that if teachers modify an assignment for one student why not modify the assignment for the whole class A multilevel assignment strategy for students allows complex assignments for higher-ability students with a larger point value and several smaller point assignments for the lower-ability and struggling students. Fairness of such an assignment grid can be argued. Is it fair that the lower-ability student must complete more problems?

Tomlinson (2003) further states that educators must embrace the concept and differentiation must become a way of life for the educator as well as the student. Effective differentiation is driven by educators embracing that each student is not a standard student. Differentiation does not allow for a substitute of high-quality curriculum; however we must also build connections between learning and learners. Deep respect for a student's identity allows for the student to succeed. "Respect the readiness level of each student. Expect all students to grow, support their continual growth, offer all students tasks that look intriguing and are equally interesting, important, and engaging" (Tomlinson, 1999, p. 12). Heterogeneous classrooms greatest threat and challenge is the mismanagement of the extreme abilities within the classroom (Loveless, 1998).

Chapter 4: Authors Classroom

The research of differentiated classroom and curriculum created options for the author to research further put into practice and review the following: staff development, grouping, and strategies.

STAFF DEVELOPMENT

In a one section rural school where students of a specific grade level spend the 44 minute period in a cohesive setting, the task chosen is to educate students inclusively in the classroom. Differentiated instruction for 110 mathematically diverse students who are part of six different classes is a large undertaking. At the beginning of this research, investigation and implementation, this author chose to focus on the ninth grade algebra class.

Differentiated instruction appeared to fit the needs for students of mixed ability in this one section school. However, with limited knowledge of the process, sources, and minimal staff development opportunities in this remote rural school with one mathematics educator, the research and developing of a differentiated program was and is on-going for the educator.

The research, workshops, professional reflection, and differential instruction options this paper discusses were used, evaluated, practiced and refined. Since that beginning eight years ago, differentiated education has received a great deal of press. Publications and staff development opportunities are now more readily available. However, most differentiated discussions of

curriculum development are targeted toward the elementary and middle school classrooms. This could be due to schools that are able to offer mathematical class choices for their students from seventh grade through the twelfth grade curriculum; unlike the school at which the author is employed, where students follow a year by year class schedule.

Developing differentiated instruction for the high school mathematics classes required time and research to develop the curriculum, and no assurance it would work at the high school level. Research data available for differentiation of students beyond the middle school grade band was very minimal. Are high school students willing to make a positive effort and be open minded regarding a very different classroom style than they had experienced by this instructor or previous educators?

KNOWLEDGE BASE

To begin the process of differentiating the classroom, research, practice and self evaluation supported by data were helpful (Burris & Garity, 2008). The evaluation data were acquired from student assessments, interest surveys, and prior knowledge of the students. The data were used to create instruction tailored to each student or group of students as was deemed necessary.

Student knowledge base is one of many components in developing engaging and appropriate differentiated lessons for a particular group or class of students. Many factors are taken into consideration in the classes. Since the author has been the mathematics educator for all seven through eleventh grade mathematics students, the educator has the ability to know the students'

personal knowledge base and watch them change and develop mathematically over five years. When the students arrived in the authors classroom as seventh grade students years of data arrive with them. However, beyond the existing data, pre and post assessments for the first semester also were used to assess what they have retained that can be built on and what has to be reviewed, or reintroduced to some students while others are ready to move on to more challenging material. The data from standardized tests also is charted to observe or discover trends in personal students or classes of students. These assessments expose students who have reading and comprehension problems as well and will require modifications to move past the limitations caused by poor reading skills. Once all the data are reviewed the choice is which instruction option to use in the differentiated classroom setting. One early assumption made was that all lessons have to be differentiated, this idea was overwhelming. It was very valuable to learn that all lessons may not require differentiation (Nordland, 2003).

GROUPING

In larger schools, students self track, choosing classes according to self interest, ability or from input by parents and teachers. It could be said, due to our enrollment numbers, students are forced into a set mold or schedule that would lead some to believe if you are in the tenth grade, that's the best year for you to be in the geometry class. Unfortunately, all students do not mature at the same rate or are ready for mathematical concepts along the same time line.

Once the decision was made to transform the classroom using differentiated instruction, the author had many choices to make with little guidance to create the differentiated classroom. Classroom management through grouping or clustering is one such decision. How to group classroom students to work with peers cooperatively as discussed within the differentiated curriculum research. Differentiated classes encourage student collaboration and rely on independent thought process as well. This educator found that flexibility was necessary, and some collaboration would need to be readjusted as student needs become apparent or curriculum deems a change is needed. Students struggle with what is appropriate group collaboration and what is copying or non participation within collaborative lessons. Careful monitoring and recirculation among students helped to guide students through the parameters necessary to encourage self exploration and problem solving while keeping discussion open between students during lessons. Collaboration provided “comfort” zones into the unknown through challenging tasks. Students were encouraged to make attempts, investigate and discuss solutions without the concern of peer pressure from a large group. Tasks for the groups or individuals based from the earlier mentioned student knowledge base or data, learning styles and personal intellect are blocks to base the foundation of the differentiated classroom (HDI, 2011).

Cluster groups give students opportunities to mix with their peers in varied arrangements for labs, discussions, tutoring, projects, and investigations. These types of groups create a heterogeneous atmosphere within the classroom allowing a wide range of student abilities and ideas. There is a place and time for large groups as Nunley states, it builds community and the smaller cluster groups allow for more individualized attention (2006). Multiple intelligences as

Gardner (1993) discusses, as well as the cooperative learning component based on earlier research are guides to the grouping or non-grouping of a classroom.

DIFFERENTIATED INSTRUCTION STRATEGIES

Research explores several differentiation options that are available for the differentiated classroom/curriculum development. Several of the options or big ideas are done on a daily basis, others for specific lessons, or classes of students are used when they are applicable to the situation, lesson and students involved. Some options discussed in this paper have gone unattempted as they do not meet the demographic needs of the author's students and/or classroom.

Tomlinson stated that a differentiated mixed ability classroom must be built with varied approaches, process and product in direct correlation to student differences, interest and learning needs (2001). The goal in my classroom is to ensure students are given the opportunity to reach their full potential. Through organized and flexible approach, using teacher support, challenging curriculum, adaptive lessons. The result is students' assessments are showing growth. Within my classroom students have completed graphic organizers, reports, journals, projects, puzzles, and posters as well as traditional assessments. It is interesting to note that students preferred the more traditional assessment such as tests, quizzes and exit slips. Students did not feel the traditional assessments required as much preparation, even though they performed stronger and retained the knowledge longer through afore mentioned non-traditional assessments.

Students are encouraged to use graphic organizers, allowed to work independently as well as in grouped activities, interest groups and centers to open avenues through guided strategies to achieve individual academic goals. Students are given opportunities to make choices, use visual materials, discuss orally or by written response, share planning, engage in discussions and be creative in their attainment of their mathematical goals. Another technique used in the classroom is open questions so all ability levels can be involved (Small, 2010). The idea of a broad concept discussion has worked well for me as a pre assessment. Students discuss what they believe is the “big picture” allowing a non threatening open assessment of the class, or group of students.

CLASSROOM MANAGEMENT

Students at times did not feel the requirements assigned of them were fair and equitable (Nunley, 2006). Students who were excellent problem solvers and had demonstrated a good work ethic were still at times quite lazy and immature and would rather choose the easier route. When students would compare assignment options and choices, or assessments, students at times felt another student’s assignment was much easier. They would rather complete tasks beneath them putting in minimal effort, instead of working toward a deeper or more challenging level suited toward their ability. This is another piece of the differentiated classroom that is a challenge to manage.

In the research it stated that students preferred worksheets to textbooks. The students’ confirmed this. However it was due to students idea of the portability of the worksheet, it was all

they needed with them to complete. Without the text, class notes and examples for reference, the worksheets may be preferred by students, but not always are they successful. To resolve the issue of lack of reference material as a group we complete a portion of the assignment. Students finish the assignment independently with an opportunity to discuss questions before self correcting or turning in the assignment. Manipulatives and games are also student “pleasers” however; these options require extra attention to solid planning and strong classroom management to keep the activity organized and to achieve the desired outcome.

CONCLUSION

Tiered lessons, centers, and products as well as portfolios are strategies that have not been used in the author’s classrooms. Further research of the processes and designs of these methods needs to be done to decide if they fit into the scenario of these classrooms. The use of differentiation in these classrooms will continue, as it has become a permanent part of the classroom management and curriculum.

This educator plans to share the challenges of differentiated classroom as well as the successes through the media of print within the MCTM Math Bits periodical and the spring math conference. Feedback from other teachers who are differentiating their classrooms will be appreciated as well as learning of educators’ successes and challenges in their classrooms.

Differentiated instruction is effective ways to instruct students. The author finds it keeps the mathematics fresh and different so students are engaged and creative in their understanding of mathematics allowing for the nurturing of mathematical depth. Teaching students to think and problem solve is the goal, and differentiated instruction allows an avenue for students to achieve their individual academic goals through lessons molded around the various individual levels of the learners.

Chapter 5: Conclusion

Educators have been challenged throughout history to meet the needs and challenges of a diverse student population. Whether the challenge to educate all students is driven by the teacher, district or government, it is agreed that students must be challenged to achieve a level of education that will allow them to become successful participants in society.

Throughout this research, many options within the heterogeneous classroom were reviewed. The education strategies of differentiated instruction have many components and options within the components. Staff development is a necessary piece of self education to understand, practice and refine the components and multiple options involved. This researcher found workshops, the internet, and the authors of differentiated instruction had varied views and ideas. Tomlinson (2005), Nunley (2006), and Loveless (1998) as well as other authors in this research review based their differential instruction development on Gardener's (1993) multiple intelligences and findings of earlier researchers. This history and development of differential instruction creates a solid base to begin the process of developing a differentiated classroom and curriculum.

Several grouping options within the differential classroom allow the author to keep grouping flexible to meet the challenge of educating low to high achieving students. The benefit of knowing the knowledge base of this educator's students is due to a one section school. A one section school creates a strong understanding of each students' strengths and weaknesses. Through the knowledge base, strategies of differentiated instruction are selected to create a strong learning

environment in a differentiated classroom where students are encouraged through meaningful knowledge base appropriate activities and work to enhance and encourage educational growth.

Classroom management can be a successful bi-product of a classroom where students are actively engaged and who feel the lesson or activity are viable, challenging and have value. Careful classroom management will encourage students to engage in their learning or discussion process allowing educational growth to continue. Students allowed to achieve, be challenged and grow educationally meet the requirements of state mathematical mandates, personal goals, as well as becoming career and college ready.

This author and her students have found benefits in this research process. Some of the differentiated strategies have been used in the classrooms. Grouping techniques as well as choice boards and compacting to name a few. Choice boards required a great deal of preparation to develop, manage and assess when used for daily or weekly concepts. Projects and choice boards created options for students to establish a sense of ownership and interest through the choices. Compacting strategies were found to create blocks of time. The support of knowledge base with data allowed material, at which students were academically proficient, to be compacted and used with new or challenging material.

Educating students of mixed ability in a cohesive classroom setting creates obstacles, challenges, successes and rewards. Thoughtful innovative differentiated instruction, when appropriate, allows students of all abilities opportunities to learn. The success in the classroom for students opens doors for successful careers and college opportunities.

During this research the struggle was locating research based on mathematics in the high school setting. Many of the articles that were cited in this paper were documentation based on preschool to the middle school classrooms. This author would like to see the research continued into the high school and college levels. Several of the authors researched provided charts, reproducible organizers and other manipulatives for educators to use in their classrooms. Some of these still were usable in the middle school and high school classrooms. However, there is a need for more of these tools at the high school level.

This educator will continue to use staff development opportunities to enhance her personal knowledge base to continue the process of differentiated instruction in her classroom. She also plans to share her research with peers through the means of local educational workshops and periodicals. Differentiated instruction is a strategy that can be used to meet the needs of students as well as the requirements mandated by government, or district to educate students to their fullest potential.

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