Draw the Line – Differentiating Instruction in a Science Classroom

by

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Abstract

By focusing student lessons around individual learner styles and intelligence modalities I have impacted my professional growth, and also promoted student growth as learners. Seventy two eighth graders were assessed for learning styles and strengths. These assessments were used to create individual and differentiated lessons for a Force and Motion unit. Pre and Post data included student surveys, student interviews and standardized test scores with support provided from a researcher journal.

Introduction

Many secondary students view science education as difficult and even unnecessary. More and more, I observe my students are struggling in finding motivation to explore science. Traditional methods of teaching science such as lecturing, note-taking, predetermined laboratory experiments, and testing may make it difficult for some learners to connect with their educational experiences and to develop a sense of the value of science in their everyday lives. I have witnessed first hand the dislike of science, and school in general, from students in my classes. Perhaps this generation needs more stimulation, more personal experience, or more enticement. I believe that much of what drives students are their interests outside of school, with peers, pop culture, and to some degree, their families. With this in mind I began to wonder what I could do to help students find significance in their learning. More specifically I began to question how students learn, and if my current practices were providing them opportunities to explore scientific concepts in exciting, meaningful ways. The more I thought about it, the more I wondered if my students' perspectives on science were negatively impacted by my teaching methods.

I have always been reflective of my teaching and open to communication with others regarding how I can best help my students succeed. I engaged my building principal, who has mentored me throughout my teaching career, in many of these conversations. She introduced to me the idea of differentiated instruction. I was intrigued to learn how I could incorporate learning styles, diverse intelligence abilities, and interests of my students into my district's curriculum. I began to use simple differentiated lessons and found that they seemed to have a positive impact on my

students; they were more interested in what we were learning and able to connect their lives to science in more lasting ways. At least, so it seemed.

By focusing my action research around my educational practices, I am hoping that I can not only impact my own professional growth, but also promote student growth as learners. It is my belief that differentiated instruction can become the backbone of my educational approach within all my classes in the future. I also believe that I can help shed some light on the practices involved in differentiated instruction, so that other educators may also see value in them.

To help evaluate the process and significance of my action research I have enlisted the help of a support team. Some of these individuals have helped me throughout this process while others have come on board in midstream. These include:

- Bill Hug: Education professor at Montana State University. Selected because he was instrumental in the initial conception of this research project.
- Dave Lageson: Earth Sciences professor at Montana State University. Selected because we share a passion for sciences and education.
- Kim Anderson: Principal at Evergreen Junior High School. Selected because she is the only person to visit my classroom on regular basis and her input into my direct instruction is highly valuable.
- Laurien Rahimi: Principal at Fort Mackenzie High School. Selected because she is familiar with my action research, and helped me develop my focus question. She had specifically asked that she be kept "in the loop" regarding my action research even though I was moving from her district.

- Randy Schumacher: Fellow colleague and Science Teacher at Evergreen Junior High School. Selected because I work in direct conjunction with him on a daily basis and am responsible for directing the curriculum that we both teach. In reality we are constantly trying to bounce ideas off one another and his opinion is highly valued in my mind.

Focus Question

This research will focus on the implementation of differentiated instruction within my classroom. Specifically I will be concerned with addressing students' learning styles, intelligence modalities, and interest levels while creating lessons. It is my desire to also impact students' attitudes towards science and their perception about the world around them in relation to concepts they have learned in science. My focus question is: How will the focused use of differentiated instruction help motivate students to transfer science knowledge to their lives outside of school? From this focus question stem two sub-questions: How do student attitudes towards differentiated instruction change with a focused approach? How does student perception of learning change as students experience a more differentiated approach?

Context

Personal Background

I have been a teacher for seven years, most of those at Fort Mackenzie High School in Sheridan, Wyoming. I recently changed jobs and just completed my first year teaching at Evergreen Junior High School outside of Kalispell, Montana. The district I work in, Evergreen School District #50 is a K-8 district that feeds into Kalispell School District #5. Our 8th graders will be attending a brand new high school next year, Glacier

High School, as Kalispell will become a two high school city in Montana. Evergreen Schools serve approximately 800 students, and generally consists of the lowest socio-economic status in the Flathead Valley.

I teach 7th and 8th grade Life and Physical Science to approximately 120 students a day, during fifty minute periods. Teaching in Evergreen has been a dramatic shift for me as I was accustomed to much smaller class sizes and longer class periods. Furthermore, the student population is much larger, younger, and generally more poverty stricken than those that I was previously teaching. My transition has progressed to the point that I am comfortable knowing what we can accomplish within the allotted timeframe and how to build rapport with this age group and demographic. I have two science colleagues at Evergreen Junior High School. We collaborate regularly to write the curriculum for both 7th grade Life Science and 8th grade Physical Science.

The staff at my school is extremely open, friendly, and encouraging. We communicate frequently and keep each other upbeat. This has helped me to stay centered on the task at hand. Our principal encourages us to collaborate frequently, and we are continually implementing new strategies to help our students read and write better. Our district is very concerned with making Adequate Yearly Progress every year, so much of what our principal encourages us to do is to better prepare these students for assessments. The expectations in our school are high, and we have some great kids who make strides everyday. The environment I work in is a remarkable, fun, and challenging place.

Research Background

Since many of the students I teach want nothing more out of school than to graduate 8th grade and become a high school student, most do not think much about

future plans. As a result, I have had to be very creative in the classroom. Many of my students are not intrinsically motivated, and I find that much of what I do is geared toward finding ways to incorporate student interests with my learning objectives. Obviously, there are times when this is easy, and times when it is near impossible. Regardless, I strive to provide opportunities for students to see real world applications and impacts on the conceptual knowledge and skills they are learning and exploring. I try to involve local agencies in my classes to help students see how these practices are carried out in reality and hopefully spark some interest in future career plans. Students carry out experiments completely, from their questioning stages through the documentation. Much of what they do in the classroom is individualized, but they also receive some traditional teaching throughout the course.

It was my intention to research my practices using two approaches, an 8th grade Physical Science experience in which differentiated instruction was secondary in consideration when planning lessons, and an 8th grade Physical Science class in which all lessons are differentiated. By comparing the results from each class, I was hoping to get an accurate picture as to how effective I am at using differentiated instruction to help students successfully find value in their science education, and how it helps them connect to their experiences outside of the school environment. As this project evolved it became logistically impossible for me to provide these two unique experiences, and each group of 8th graders participated in the differentiated experience together.

For the most part, I think students enjoy my classes, and I know that I have been an effective teacher to some students and, in particular, with certain subject matter. I have a good rapport with students, and enjoy teaching, but the central theme behind my

action research is to employ new techniques that will make me effective with all students and any subject matter that I may teach. I am really excited to be on this journey. I am hoping that I can hone some of my strategies down, particularly in dealing with reluctant learners.

In the past, I used learning contracts with students. Students were presented goals, objectives, and tasks that they need to accomplish before they can inquire and experiment. Some of these tasks are required, and some are chosen by the students. I liked the possibilities that these choices provided students and wanted to continue using them in some aspect of differentiated instruction. I was particularly interested in exploring how these choices may fit the learning styles, intelligence modalities, and interests of my students in that particular class. This is one of the reasons why differentiated instruction is so inviting to me.

Conceptual Framework

Education is continually evolving. The educational practices that were once used extensively by teachers have been modified, altered, and in some cases dropped completely through the processes of school reform. Inclusive classrooms have become the norm, and some unique approaches to facilitating learning for students within these classrooms have become available. One of the most successful approaches, differentiated instruction, has "presented increased opportunity for students to receive individualized attention and instruction" (Skowron, 2001, p.2). For the teacher with at-risk students, this instructional style can be very valuable.

Traditionally, education has tested and classified students in terms of ability types; some examples include the ability to memorize information, the ability to analyze,

and the ability to apply knowledge. Likewise, educators have tended to teach in ways that emphasize memorization and analysis: lectures, note-taking, reinforcements, quizzes, and finally tests. Many students who do not excel at these tasks get labeled as slow or at-risk for failure, and although there are other environmental factors that may influence this such as large class sizes and/or short class periods, some of these students may be more successful with a new approach. These students may excel in other tasks that are at least as important in society, such as creativity and practical application of information.

Research has shown that "students whose instruction matched their pattern of abilities on intelligence scales performed significantly better than others; this is true if even partial matches of instruction to ability took place" (Sternberg, 1997, p.249). By simply assessing students on their intellectual strengths, analytical (recall and analysis), creative (imagine or design), and practical (use or implement), student achievement can improve (Sternberg, 1997). Teachers may begin to see the concrete evidence they need to plan lessons and address individual student needs. Furthermore, students might be better able to recognize what types of tasks they may find successful in the future. "When combined with altered instruction, intellectual assessments can impact all involved positively" (Tomlinson, 1999, p.62).

The various modalities of intelligence levels are sometimes overlooked and unrewarded in many classrooms, and many of these students can begin to fall through the cracks by getting discouraged, feeling undervalued, or believing they cannot succeed in school. For example, I currently have an eighth grade boy who is capable of building models describing Newton's three laws of motion using computer programming but has done poorly on classroom tests because he struggles with test anxiety and attention. I

also teach a young lady who can build an extremely aerodynamic model race car but struggles with the concept and definition of aerodynamics on paper/pencil tests. The fact of the matter is there are many students that may not be provided a medium with which to learn and process information.

The unintended consequences of a traditional approach to education are great. We may be discouraging many students from learning and emphasizing skills that, to a large degree, may be invaluable to students who enter creative or practical domains when they leave school. In fact, when researchers have examined the lives of enormously influential people in these domains, they have found many of them were ordinary or even mediocre students (Sternberg, 1995). By understanding Howard Gardner's eight intelligences, students can acknowledge the different styles of learning. He lists eight different ways of learning and thinking: verbal/linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, musical, interpersonal, intrapersonal, naturalist (Gardner, 1995). Students that are able to recognize their learning styles will be better able to identify learning mediums that work for them. A student who recognizes their strength in interpersonal intelligence for example, may seek groups to work and learn with, provide structure during cooperative activities, and pursue leadership roles that they might otherwise not accept.

Intelligence design can also be described more simply, as analytical, creative or practical, but this is not the only consideration when evaluating traditional educational practices. Interest levels, readiness, and learning styles (auditory, visual, and kinesthetic) are also important factors that should be incorporated into instruction. Asking students what they are interested in outside of school with surveys is a great tool for teachers.

Likewise educators use pre-assessment tools to determine the readiness levels of their students so that lessons can be catered to match individual needs in association with prior knowledge and eagerness. This knowledge can help teachers clarify key concepts for students, allow assessments to extend instruction, and provide a platform for balancing between teacher initiated tasks and student initiated tasks. Engaging students is the number one priority.

Differentiated instruction is a teaching approach that "provides a variety of learning opportunities to accommodate differences in how students learn. Some differences that impact learning are related to the student's prior knowledge and experience, learning preferences and modality, cognitive level, and personal interest" (Skowron, 2001, p.1). By providing students with individualized instruction that matches their abilities and interests, students can more easily be challenged and grow. This process is very holistic and student centered. Differentiation in the classroom usually occurs in specific areas of instruction; the content, the learning process, student outcomes, and the learning environment. By differentiating content instruction, students begin learning where their prior knowledge falls off. Differentiating the learning process provides learners access to information in modalities that match their learning styles, and differentiating the student outcomes can appropriately challenge students. Educators have used many strategies to encourage differentiation in their classrooms. Flexible grouping, curriculum compaction and tiered assignments allow students with various abilities to work towards the same learning objectives and across learning mediums (linguistic, logical, musical, kinesthetic, visual, interpersonal, and intrapersonal) while maintaining an appropriate challenge level. Peer teaching, learning contracts, and

anchoring activities have also been used as strategies. The teacher acts as a facilitator rather than an instrument of instruction.

Tomlinson reports that differentiating instruction like this is a "way of proactively adjusting teaching and learning to meet students where they are and help all students achieve maximum growth as learners" (1999, p.61). This is not to say that the teacher does not benefit as well. If expert teachers are attentive to students' varied learning needs, then "to differentiate instruction is to become a more competent and professional educator" (Tomlinson, 2000, p.3). Most educators would like to be experts, and so too would society. Differentiated instruction is a simple process by which they can begin to engage that transformation. This process is different from that of individualized instruction in that groups of students may all be working on shared concepts or projects, but students have opportunities to examine various modalities that they may or may not be familiar with.

Many stereotypes exist within an at-risk population: low socio-economic status, ethnicity, intelligence, etc. Yet, the reality is that most at-risk populations are extremely diverse, and include many students who do not fit traditional stereotypes. Research has shown that by expanding the range of abilities we test for, we also expand the range of students we identify as smart and start breaking down stereotypes (Sternberg et.al, 1995). If we expose students to instruction emphasizing differentiation, we help them capitalize on their strengths while developing new skills that they may not have explored in-depth. For the at-risk student, this process can become an eye opening experience.

If we examine the reality further, in order to make differentiation work, teachers must "develop an alternative approach to instructional planning beyond covering the text

or creating activities that students will like although these may provide success for some" (Tomlinson, 1999, p.13). Teachers need to know where their students need to arrive at the end of their learning journey and where they are along the way. By varying or differentiating our instruction we can help construct understanding. To be truly successful, this differentiation cannot be a stand-alone matter, but squarely rooted in student engagement combined with student understanding. Students need to take ownership in their learning. Teachers have a great responsibility to provide an environment where this is possible and the first step in creating an encouraging atmosphere is providing students a voice within the classroom. Differentiation does this by providing students with realistic options directed at individual learners, and by validating and acknowledging student needs and opinions regarding their learning.

Research has shown that an "equitable classroom requires deliberate interventions to produce equal-status relationships within the groups. Failing this last step means that some students will not have equal access to learning" (Cohen, 1999, p. 268). A teacher who provides students an open-ended, interdependent group experience can provide interventions such as ensuring that all group members are active and get their opinions heard. In their small groups, students help academically and linguistically with one another. Researchers call this complex instruction. Differentiating instruction encourages this type of classroom interaction and allows all students, especially low-status students, the possibility of receiving a positive evaluation. Cohen and Lotan (1997) found evidence that differentiated instruction boosted participation of low-status students while not suppressing the contributions of high-status students, despite the low overall frequency of teacher's use of differentiated instruction. The argument must be

made that diverse learning groups can only benefit from an equitable classroom. By engaging students with applications that are stimulating, enriched, goal-oriented, and student-centered, we can produce an outstanding and pro-active instructional framework for students to engage with.

In the early 1980's Howard Gardner published a multiple intelligences theory in a book titled *Frames of Mind* which describes seven intelligence types: linguistic, logical-mathematical, musical, bodily-kinesthetic, spatial, interpersonal, and intrapersonal (Gardner, 1993). He has since added an eighth intelligence type, naturalist. Beginning in the mid 1980's many educators have embraced these ideas and used them to further stimulate learning in their classrooms. Linguistic intelligence includes an aptitude for spoken and written language. Logical-mathematical intelligence directly involves analyzing problems logically, following specific procedures (such as in scientific inquiry), and calculating data. Musical intelligence is the ability to perform and compose musical patterns while maintaining an appreciation for all forms of musical expression. Bodily-kinesthetic intelligence is expressed when body parts or the entire body is required to accomplish tasks successfully. Spatial intelligence is the ability to utilize and recognize personal surroundings on a large and small scale. Interpersonal intelligence is centered on the understanding of other people's intentions, needs, and drives. Intrapersonal intelligence is the ability to understand the self, and to accept one's beliefs, emotions, and desires. Naturalist intelligence is the ability to recognize, organize and relate to certain components of the environment. These intelligences are part of the foundation of differentiation occurring in classrooms today and will be a large part of this action research.

For the purpose of this research project I am choosing to use Tomlinson's brief definition of differentiated instruction. "At its most basic level, differentiating instruction means "shaking up" what goes on in the classroom so that students have multiple options for taking in information, making sense of ideas and expressing what they learn. In other words, a differentiated classroom provides different avenues to acquiring content, to processing or making sense of ideas and to developing products so that each student can learn effectively." (Tomlinson, 2001, p.1)

Methods

In this section I will describe the process by which I determined how my classroom would be differentiated, including a description of the types of tools used to assess students. I will also describe the techniques used to evaluate this action research and how they were developed. Finally, I will attempt to provide some insight into what this differentiation actually looked like in my classroom by providing specific examples of three differentiated lessons for individual learners all working toward the same learning objective. I chose to focus my action research around my 8th grade Physical Science classes, and more specifically around a Force and Motion unit.

Creating Student Profiles

Students in my classes were assessed for learning styles (auditory, visual, or kinesthetic), intelligence modalities (linguistic, logical, musical, kinesthetic, visual, interpersonal, intrapersonal), and interests. The tools for these assessments can be found in the appendix. They include a survey adapted from an educational program called Quantum Learning that uses brain research to help teachers and students address learning

styles, a multiple intelligence survey adapted from Howard Gardner's Multiple Intelligence Model, and an interest survey that I created.

These three surveys were used to create student profiles and this new knowledge was used to plan lessons that directly target different student learning styles, intelligence modalities, and interests. In order to do this and keep students accountable for learning, students were presented with choices as to how they could meet the learning objectives. Each choice focused on a specific learning style, modality or interest, but students freely made their own decisions regarding their educational experience. Students still received direct instruction on some of the key concepts and lesson objectives. Students were aware of the purpose of this action research and were introduced to this idea of differentiated instruction to help ease this transition from past classroom procedures. Throughout the course of this treatment, students worked both as individuals and as members of a facilitated group.

During the treatment, traditional methods, such as lectures, note-taking, worksheets, and review questioning were not the focal point of instruction. Rather students were responsible for their own education, and worked on different tasks within the framework of the course objectives. This is not to say students had complete academic freedom. Student lessons were created with them in mind, but students were still responsible for meeting the requirements of the activities provided. We met frequently to discuss their progress, and students were provided many opportunities to share their products with others. Students sometimes felt that the choices provided for them were not adequately differentiated enough, and these issues were addressed individually as they arose.

Differentiated Lessons

The unit I chose to focus this action research was Force and Motion (defining energy in terms of motion). Students were given two essential questions for the unit: 1. How can the motions of objects you see every day be described in the same way? 2. What affects do various forces have upon the motion of objects? Initially, I taught core concepts and stimulated the connection of prior knowledge through guided discussions and activities that helped develop a common language. After we had some common understanding of the foundations of what students needed to know, understand, and be able to do, students were given a list of various tasks they could choose to utilize to participate in some mode of differentiated learning. The first lesson focused around student interests, and intelligence modalities. Students then used applications that included a tiered assignment in which students were grouped according to their readiness levels and met similar but unique learning goals, a web quest for facilitated groups that was geared toward various intelligence modalities to help produce a final project, and a choice from three predetermined assignments based on learning styles. Regardless of the task, lessons were all planned around the population of learners in that classroom and completely unique to their learning modalities, skills and interests.

The student objectives for the first section of this unit were to define distance, speed, and velocity and to graph motion. Initially, students were introduced to the ideas of distance and displacement, speed, and velocity by reading our textbook aloud and discussing the core concepts as we read. We created a concept map on the board and elaborated on subjects that we thought might correlate from previous units. Students then participated in a whole-class activity to calculate and measure speed by plotting the speed

of students moving across the classroom by various means (walking, hopping, crab-walking, etc.). Students were then presented with three differentiated lessons to help with understanding.

I focused the first section of differentiated lessons around student interest levels and intelligence modalities. Some students chose to research information using the internet about how the land speed record of cars or motorcycles has changed over the past century and create a graph showing the increase over time. This lesson was selected because I had ten of my students report that they were interested in motor sports and it also encouraged the logical-mathematical intelligence modality. Other students chose to measure their average speed during their passing periods throughout the day. Students wrote out proposals about how they would measure this and record their data. These students then graphed their results. This activity was chosen because many of my students had stated to me that their passing periods were not long enough and it also targeted the kinesthetic intelligence modality. Finally, another group of students worked as a group to create a skit that demonstrated the concepts of distance vs. displacement, average speed vs. instantaneous speed, and velocity. This group had to include a visual aid as a prop and it had to be a graph of motion. When students completed their interest surveys, five of them stated they wanted to be famous movie stars when they grew up, four of them were active in drama, and six people said they wanted to be president of the United States. This activity seemed an easy way to encourage these students and also allow some of those students who may be strong in interpersonal skills a chance to interact as a group.

The second section of this unit required students to define acceleration and predict what effect acceleration will have on the motion of an object. The differentiated focus in this section was based upon readiness levels. Students previewed their textbook as a whole-group and discussed key vocabulary and illustrations of speeding up, slowing down, and changing directions. Students took notes on calculating acceleration and were given three problems to practice. Acceleration was modeled in groups by clapping steady beats and hitting set marks spaced farther and farther apart while walking/running. We then graphed speed and time for an object that experienced an acceleration of $10m/s^2$ for three seconds, $0m/s^2$ for two seconds, and $-3m/s^2$ for two seconds. Students were assigned four practice problems the next day, one of which they needed to graph. These were graded in class and became the readiness tool I used to place them in three tiered groups the next day: those students who were unable to correctly answer any of the practice problems (Instruction group 1), those who were successful on every question but the graph (group 2), and those that did not miss a single question (group 3).

Students in instruction group 1 were asked to write two short paragraphs comparing and contrasting speed and acceleration. They had to make a concept map using words and pictures in each idea that described acceleration. Finally, they had to create a pneumonic device to help remember the units of measuring acceleration. Students in group 2 solved more graphing problems using the internet and a link provided by the textbook and then demonstrated three simple examples of acceleration using common school supplies. Each demonstration required a written explanation of the changes in velocity influencing the objects. Finally, students wrote a skit about the relationship between acceleration and collisions. Students in group 3 wrote three

problems of their own to be used on a test and solved each of them showing their work. Students then modeled negative acceleration for the class using the same activity done as a whole-class. Finally, students worked as a team to create an experimental procedure that would allow us to calculate the acceleration due to gravity. The next day, this group presented their experiment to the group and carried it through.

The third section in this unit had three specific objectives; to explain the relationship between mass and inertia, to understand momentum, and to predict motion using the law of conservation of momentum. The differentiated focal point of this third section was to provide mixed groups based on readiness levels. Students were introduced to these concepts by reading through them in their textbooks aloud and discussing them as they read. They created a vocabulary foldable with a definition and illustration of the following terms: speed, velocity, acceleration, mass, and momentum. We discussed what happens to momentum before and after collisions and the need for protection while riding in cars, playing football, skiing or snowboarding, and other sports that involve high speeds and/or high mass.

Students were then placed in mixed groups using the readiness levels that they were in during the last section and given a web quest requiring them to assume a fictional identity of a forensic investigation team that researches accidents that involve the momentum of a moving object. Each group had to research what their team's job entailed. Included were the challenges they may face during investigations, the types of investigations they may be included, tools they may use, they roles they play in society, and how their job helps make us safer. Students in each group had to create a written report, make a visual representation of their research, create a model of an accident scene

and present their research to the rest of the class orally, highlighting their understanding of speed, velocity, acceleration, and momentum. Using what students had learned, they created an impact minimizing device using Styrofoam and toothpicks and competed in an egg drop from the school's roof to demonstrate their understanding of momentum.

Finally, the student objectives for the fourth section of the unit were to describe the net force on an object, to explain why direction of a force is important, and to identify the relationship between the forces that objects exert on each other. The differentiated focus for this section was to provide an opportunity for students to choose an assignment based on their learning styles and modalities. Students wrote Newton's laws of motion and we discussed their meaning. We previewed this section in their textbook, focusing on vocabulary and illustrations. We created a list on the board of three types of friction, static, sliding, and rolling. Students read aloud about the relationship between force and acceleration and then we discussed why forces act in equal but opposite pairs and what would happen if this were not true. Students created balloon race cars to race down a three meter track. Each student calculated their average speed and used this to describe in writing how Newton's laws explain a rocket's motion.

Students were then given four choices and had to complete two of them. One of the choices was to research air bag safety and create a pamphlet that people could read that would help them in deciding to buy a safer vehicle. Some students choose to write a song or poem about the life of Sir Isaac Newton. Others chose to make a poster representing all we had learned regarding force and motion. Some students created a PowerPoint presentation highlighting the unit. Finally, some students chose to write a test for the unit complete with a key.

Data Collection Methods

In order to evaluate this process, I collected quantitative and qualitative data. Pre and post assessment scores were compared with each class to try and maintain validity. Measures of Academic Progress (MAP) assessments provided the majority of the quantitative data. Qualitative data was collected from both me and my students. This included a personal journal of the research process, interviews with students, and student surveys.

The academic progress that this approach provides was evaluated by using Measures of Academic Progress scores pre and post treatment. Although this was secondary to my goal, I felt that it was important data to ensure that I was honest to my students' achievement and growth as learners. I used student surveys and interviews to examine how student motivation and transference of science curriculum had changed during the course of this research. My personal journal measured the level of perceived improvement and teacher stress on my part. A brief description of some of the qualitative data procedures follows:

Student Survey

Students who participated in my action research took two surveys. These surveys were developed during the pilot phase of my action research in conjunction with EDCI 509 – Implementing Action Research in Teaching and Learning, a course in the Master's of Science in Science Education program at the University of Montana. I tried to address all the key components that my focus question was concerned with. With feedback from peers and professors, these questions became more refined. The surveys were administered during class with the instruction that the information would be used to

as a measure of how successful my action research was. Students were actually given the same survey twice, once prior to taking their inventory assessments and again after completing the treatment of the action research. Scores were reported on a five point scale. I reviewed the results from these surveys and used the data to evaluate growth. The surveys can be found in Appendix B. Data was gathered from this medium by calculating the average weighted response for each question and comparing the values pre and post-treatment. These values were analyzed for gain/loss to determine how the action research impacted students learning experience.

Student Interview

Student interview questions were developed from suggestions from McNiff and Whitehead's *You and Your Action Research Project* (2003), and with the help of peer review during the planning phase of my action research. I was hoping to get some candid data from a random sample of students and provide a medium to freely express opinions that might not be represented well in the form of a survey. My focus question directly asked how the use of differentiated instruction would help motivate students to transfer science knowledge to their lives outside of school. The interview questions were written to help evaluate student perceptions of their experience in my classroom and any impact it may have had on their lives outside of my classroom. The questions directly helped me analyze the effectiveness I had in engaging students and 'hooking' them in.

Who: Four eighth grade students (two boys, two girls) of ranging achievement (high to low). These students were selected randomly from one of four groups. The groups were created by separating males and females and using Measures of Academic Progress (MAP) scores to distinguish individuals that perform above and below average. The two

females selected are in the same class period, but neither of the males selected share a class with any of the others. Description of interviewers:

- Melinda (all the names are fictitious) - very high achiever and extremely successful in class. She has the third highest grade out of the 78 students that are currently enrolled in the same curriculum. Scored in the 93rd percentile on the Science portion of the MAP test.
- Susan – slight overachiever and hard worker. She puts much effort into keeping her grade above a C. Scored in the 22nd percentile on the Science portion of the MAP test. Struggles in written language and is currently on an Individualized Education Plan.
- Cody – slight underachiever but socially popular and successful. Maintains a B average with little effort. Scored in the 88th percentile on the Science portion of the MAP test (his weakest component on the test).
- Frank – very low achiever who struggles to concentrate. Hovers around a passing grade but only with external pressure. Scores in the 38th percentile on the Science portion of the MAP test. Does not qualify for special services, but struggles in written language.

Where: In my science classroom, a beautiful state of the art middle school science lab built three years ago. We crowded around one of the lab stations in a circle and shared juice and crackers.

When: Prior to taking inventory assessments and again after completing the treatment.

How: Prewritten questions to allow for flexibility and elaboration. The interviews were kept friendly and the conversation was not forcibly professional. Notes were kept to keep

track of stray thoughts during the interview and ask additional questions that were not foreseen. The interview was also audio taped for review of the interview afterwards. The following is a list of the interview questions. The same four students were interviewed before and after treatment.

Pre AR: (responses in Appendix A)

1. How are you doing right now in Science?

2. Do you think about science outside of school much?

4. Does the approach used in science class make it more interesting to you?

3. What are some things I could do to help you connect science to the world around you?

5. How do you learn best?

6. What lesson in science really sticks out in your mind? What was it about that activity/lesson that made you think of that?

7. What would help you to have more connections like that?

Post AR: (responses in Appendix A)

1. What have you noticed about your learning during the past quarter in science?

2. When you were learning science this quarter, what did you notice?

3. Is there anything that we have been doing in class that sticks out in your mind as different? What are your thoughts about this?

4. What have you noticed about your science understanding when you leave school?

5. What suggestions do you have for me if I teach another class like I did this past quarter?

Student Created Evidence

Part of my AR involves allowing students to present their understanding of concepts using various methods. This included the use of audio/visual technology in the creation of PowerPoint presentations and WebQuests. Other students created a pneumonic device, a song, and a short skit. One example is included in Appendix G.

Personal Journal

Throughout the action research process I took detailed notes on my progress, decisions, interactions, meetings, changes, and anything that pertained to this project. Additionally, I took notes in this journal during my meetings with my mentor, critical friends, and validation committee. I wrote down my feelings towards individual class periods, the research in general, and reminders for deadlines and things that I needed to get accomplished. I also recorded my stress level and my perception of student engagement when I made entries. This was done using a simple four point scale (four being most stressed and most engaged). For the most part I wrote down whatever came to mind. These journal entries were reviewed frequently, usually immediately after making a new entry providing opportunities for reflection and adjustments. There were days in which nothing was recorded, and days in which all I monitored was my stress level and perceived engagement levels.

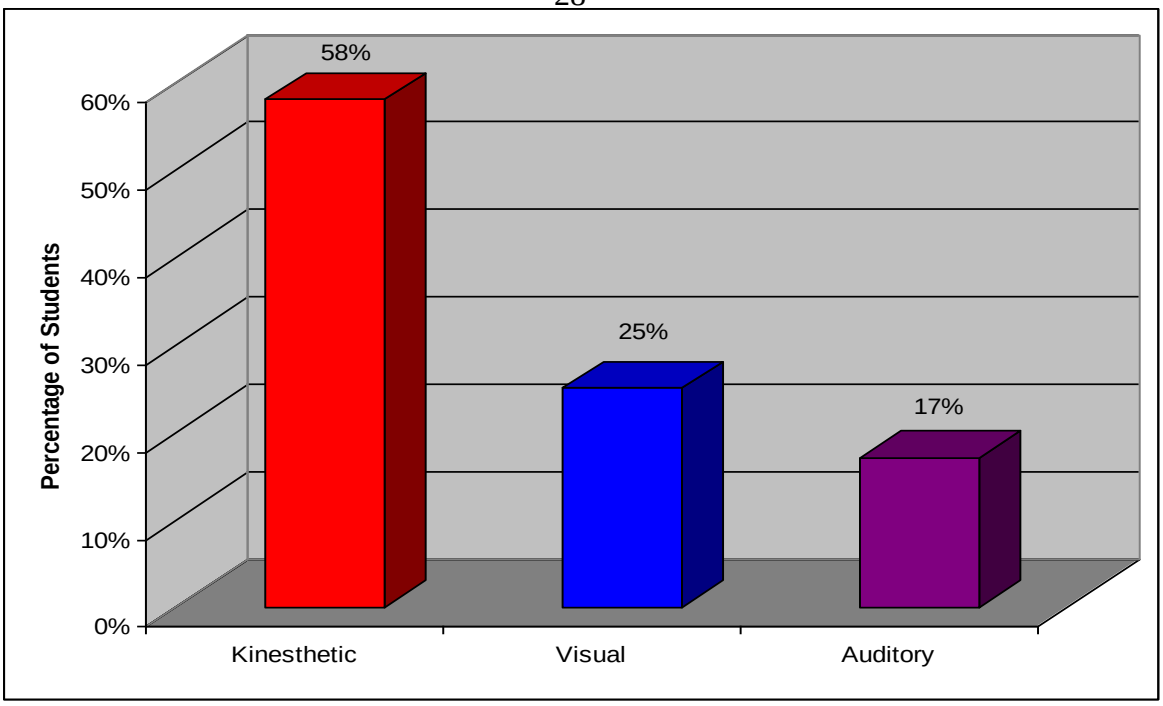
Data was gathered from this medium through the procedures explained in the Text-Based Analysis Procedures section found in Appendix F. Essentially I wrote my research questions on a large note card and kept this next to my journal as I read through the journal. I highlighted text in the journal that pertained to my focus question or to any of the sub-questions. I then re-read the highlighted data with the intention of cutting and

pasting it into a summarizing document. This highlighted text was copied and placed into sections that I thought I would address in my analysis section. The journal was re-read for a second time to make sure that there was nothing missing that should have been included in my analysis. Anything that I felt should be added was copied to the summarizing document. These excerpts were shared with my mentor and edited.

Data Analysis and Interpretation

Survey Understandings

Although I was more interested in individual's results, I thought it might be useful to get a better perspective of the group that I am teaching, especially since this is a new community to me and a new age group. I took the results from the learning style survey and intelligence modality survey and analyzed them for their primary responses. I expected the results of the learning style survey to be skewed towards the kinesthetic (especially with the boys), and the results were close to my expectations. Although this result was not surprising, it was very interesting for me to see the results for each individual. In certain instances, students had very different results than I expected. One student, for example, comes across as a very quiet, calculated and studious student who never shows any inclination to participate in anything hands-on or physical. She excels when given a written assignment and can track auditory directions well. Her learning style scores rated her as a predominately kinesthetic learner. Likewise there were a couple students who I would have surely pinned as kinesthetic learners who were predominately auditory or visual in their responses to the survey. It became clear that this survey could be an important tool to help clarify my understanding of my students.



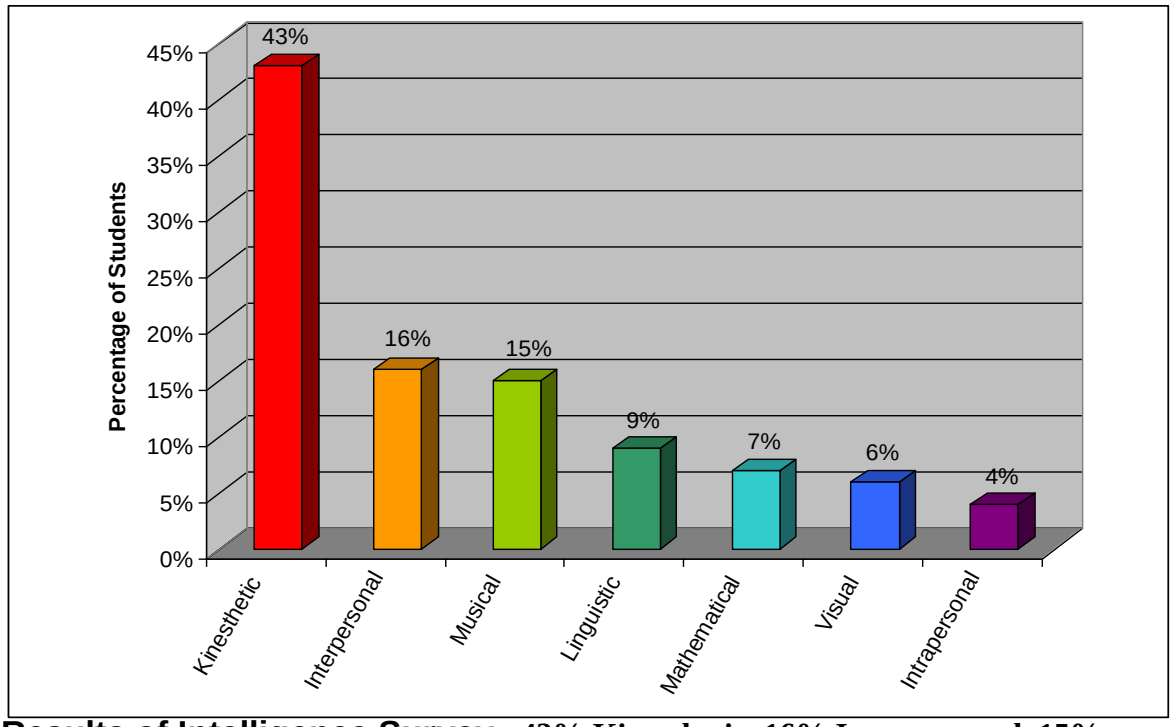
Results of Learning Style Survey: 58% Kinesthetic, 25% Visual, 17% Auditory

After seeing how predominant kinesthetic learning styles were in my classes, it was not shocking to the see the results of the intelligence survey were predominately kinesthetic as well. I was surprised by the distribution for the other modalities. This is not to say I had many expectations, I did not, but I would never have guessed that I taught so many students with intelligence modalities rooted in music and interpersonal skills. In hindsight, this should not have surprised me as any of these "musical" students are constantly singing/humming, beating pencils to an imaginary rhythm or talking about the latest batch of contestants on American Idol. Likewise, many of the students who scored themselves so highly as interpersonally intelligent are continually surrounded by peers, have many friends, like to chat, and sometimes seem overly concerned about the social aspects of school (for good or worse).

The results were also interesting in that this group of learners typically scored themselves low in areas generally thought to be so closely related to academic

achievement. A combined 22% felt their intelligence modality was rooted in a typical academic area: Linguistic (9%), Logical-Mathematics (7%), and Spatial-Visual (6%). Even the last category could be argued against being truly academic in nature. These results could help shed some light on the fact that many of these students score poorly on standardized tests. I hesitate to provide cause for these figures because it is beyond the scope of this research, but I am willing to bet that these intelligence modality results have some environmental component and could be enhanced/encouraged through a more differentiated curriculum.

These are obviously generalizations, and it is necessary to make a distinction between the analysis that was done for the group and those that were more specific to the treatment of my action research which focused around each individual learner.



Results of Intelligence Survey: 43% Kinesthetic, 16% Interpersonal, 15% Musical, 9%Linguistic, 7% Logical-Mathematical, 6% Spatial-Visual, 4% Intrapersonal

For the most part student responses to the interest survey varied greatly. However, I felt that it was one of the more valuable pieces of information that I collected during the survey phase of my research. I was not only presented with a nice picture of what each of my students liked or would choose to do, but also a little insight into their creativity or lack thereof. There were quite a few students who were clearly interested in sports and popular music, and many of them felt that they could like to live on a tropical island the rest of their lives. A couple students listed the Harry Potter series as their favorite reading material, and one student said she would stay in math class all day if given the option.

Treatment Analysis

Transfer of Knowledge

The primary focus of my action research was to study the effect that differentiation might have on the transfer of knowledge outside of my classroom. Post treatment student surveys showed that not only were students thinking more about science when they were not in school, but they were also thinking about how important science is to them in their personal lives and that differentiation of instruction had a role in this shift. Student mean response scores increased from pre and post surveys on three important questions.

Question	Pre-Survey Mean	Post-Survey Mean	Gain/loss
When I am away from school I think about things I have learned in science.	2.45	3.96	+1.51
I understand how science is important to life outside of school.	2.24	4.22	+1.98
Differentiated instruction has helped me make connections to	2.49	3.68	+1.19

science outside of school.			

These responses show some of the greatest increases in pre and post survey mean values and indicate to me that students were more likely to find instances in their lives to access scientific knowledge without being in the classroom.

I also noted in my journal entries that more students seemed to be doing their homework. Prior to implementation of my treatment, I frequently had students who would turn in homework late because they needed failed to work on it at home, but about midway through the treatment I wrote these three entries in my journal:

> *January 16*
> *Not sure if this is related, but everyone read their homework assignment last night. This is a first! They seemed pretty interested today, we will see if this just a fluke.*
>
> *January 19*
> *It happened again today, nobody forgot their homework. Today was a little crazy, but I think everyone is ready to come together tomorrow. We shall see.*
>
> *January 26*
> *This cannot be some fluke. I don't think the 7th graders have ever turned in everything in one day, but the 8th graders are now at 3. Today was another good day, but I think I'm starting to feel like I've run out of ideas with this unit.*

These three entries reinforced to me the fact that students were thinking about science much more frequently than they used to once they left my classroom. This idea was also supported by the student interviews. All four students interviewed responded that they thought about science more now than they used to when they leave school, although Frank simply stated that he watched more science shows on television now; not surprising especially after replying "No" during the pre-treatment interview when asked if he thought about science outside of school (student interview #1, 11/29/06, p.1). Melinda went so far as to say, "My parents and I discuss issues that we are learning in science almost every day. It's fun, I enjoy it" (student interview #2, 2/19/07, p.2).

Perceptions of Learning

Differentiated learning seems to have had a positive impact on students' lives outside of school, but I also wondered if my students were more willing to pursue a differentiated learning approach than they were before, being more comfortable with what exactly that entails. From the beginning it seemed clear they were excited to see how I was going to alter their class to fit their individual learning styles, intelligence modalities, and interests. Immediately after taking their surveys, students wanted to begin learning in this new "differentiated" way, but I had yet to evaluate most of the results and create meaningful activities, so I presented them with some differentiated activities that I had tinkered with in the past and this is what I wrote in my journal:

> *December 5*
> *The past couple of days students have been really engaged. I need to get this next unit planned soon. I just hope I am not setting them up for a burn-out on differentiation.*

Thankfully after the break at the end of December, students came back and jumped right into their Force and Motion unit using activities generated for them. The data gathered afterwards shows that students would like to experience more in the way of differentiated instruction in all their classes. Student mean response scores increased from pre and post surveys on three important questions.

Question	Pre-Survey Mean	Post-Survey Mean	Gain/loss
I think teachers should focus more attention on my interests when planning lessons.	4.54	4.94	+0.40
I wish teachers would address my individual learning styles more frequently.	4.81	4.93	+0.12
It would be helpful if all my teachers used differentiated instruction.	3.86	4.58	+0.72

Although these gains do not seem particularly large, it represented growth in the right direction and indicated to me that a shift in results was definitely occurring. Likewise, there were no negative changes in survey responses on statements that addressed one aspect of my research question: How do student attitudes towards differentiated instruction change with a focused approach? Perhaps the most telling response on the entire survey was a response that made me believe that students had truly been impacted from this treatment and would recognize, use, and encourage differentiation in the classroom:

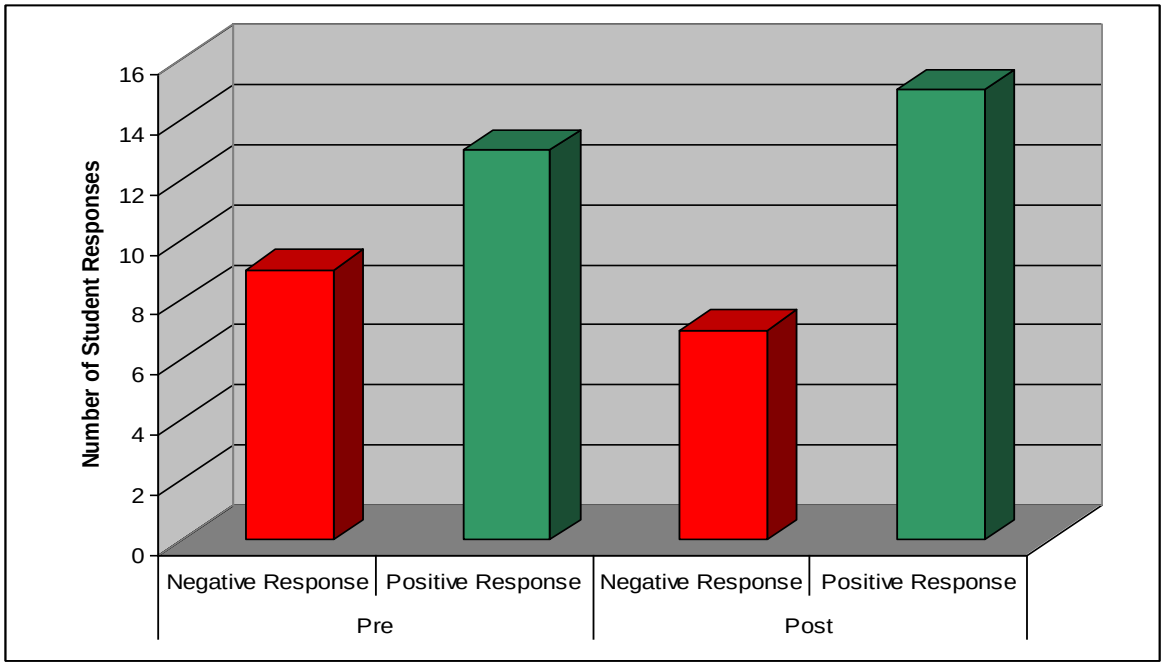
Question	Pre-Survey Mean	Post-Survey Mean	Gain/loss
I understand how differentiated instruction can help students learn.	2.86	4.18	+1.32

Students obviously were able to see the benefits of using differentiation in a classroom, and began not only to appreciate this but also began to be able to recognize tasks and skills that they were successful in. There were only two responses to the survey that showed a negative numerical change from pre to post-treatment and one was:

Question	Pre-Survey Mean	Post-Survey Mean	Gain/loss
I think that teachers have done a good job of teaching to my interests in the past.	2.68	2.40	-0.28

It is my belief that this is primarily due to the fact that students were better at evaluating what their teachers had done in the past now that a class was focused around their individual learning attributes.

Students seemed more likely to be encouraged by this type of learning and in return I felt more encouraged to pursue it. Susan said to me in her interview, "I think that you should try and differentiate all your classes just a little." When I asked her why, she said, "It's only fair to let every student know what works for their brain and then teach that brain" (student interview #2, 2/19/07, p.1). Throughout the course of this project there were many short instances like this that helped encourage and convince me that differentiating instruction was not only helpful, but perhaps vital to most of my students.



Results of Pre and Post Interviews: "Negative" responses decreased while "positive" responses increased during post treatment interview.

As far as student perceptions about how much more they have learned it is obvious from the data collected that students felt their learning was impacted positively as a result of differentiated instruction. This information hit me hard and made all my hard work worthwhile. Susan said to me, "Everyone seemed to understand the ideas better." (student interview #2, 2/19/07, p.1) Her response resonated true with me.

Responses on the student survey also showed that student perceptions about learning had improved. Each of these survey responses scored higher post treatment.

Question	Pre-Survey Mean	Post-Survey Mean	Gain/loss
I think I am better at learning science than other subjects.	3.29	3.44	+0.15
I learn more in science now than I have before	3.35	4.11	+0.76
I can easily recognize what kinds of assignments I will be good at in science.	4.29	4.59	+0.30

Performance Indicators

I wanted to know how valuable this approach was in relation to academic achievement (a measure with which I feel much ownership), and I needed to know if students learned more during this treatment than they had before, or at least perceived so. Students took the Measures of Academic Progress test in September of 2006 and again in May of 2007. The results of these tests are presented as RIT scores. RIT stands for Rasch Unit, a curriculum scale developed by Northwest Evaluation Association that uses individual item difficulty values to estimate student achievement. Advantages to the RIT Scale are that it can relate the numbers on the scale directly to the difficulty of items on the tests and it is equal interval. Students' mean RIT score in September of 2006 in General Science was 207.1, with the median RIT score 208 and a standard deviation of 10.4. Of the students tested, 23% were proficient and above. The mean RIT score in Concepts and Processes was 208.1, with the median RIT score 208 and a standard deviation of 8.8. Of the students tested, 15% were proficient and above. Students' mean RIT score in May of 2007 in General Science was 211.9, with the median RIT score 212 and a standard deviation of 8.4. Of the students tested, 38% were proficient and above, an increase of 15% (or twelve students). Students' mean RIT score in Concepts and

Process was 213.1, with the median RIT score 213 and a standard deviation of 8.3. Of the students tested, 34% were proficient or above, an increase of 19% (or thirteen students).

Test	Mean RIT change	Median RIT change	% Proficient change
General Science	+4.8	+4	+15
Concepts/Processes	+5	+5	+19

Although growth for individual students was observed in 72% of the students taking the test, I was a little disappointed with the results of the Measures of Academic Progress test. I had hoped and expected to see very large values of growth between the fall and spring, but the results seemed somewhat lackluster. After discussions with other teachers, my building principal, and students I believe some scores could have been influenced by circumstances beyond my control. The science portion of the test was administered on the last Friday before our eighth graders left on a three day Montana History trip, and students had been testing all week. Some burnout may have been present. Additionally, students felt that a large portion of the test assessed their knowledge in life science, which is part of the 7th grade curriculum at our school. I have no direct evidence about the type of educational experience these students received last year, but many of them felt they were unprepared for some of the questions, especially those regarding cellular functions, genetics, and ecology. Regardless, I will continue to evaluate progress this way in the future.

Additional Observations

This data analysis would not be complete without a discussion of some noted concerns and suggestions. There was one response on the survey that I could not seem to come to a conclusion about. Students responded that they were struggling more in science class *after* they had finished their treatment. Perhaps student perceptions were more accurate about their understanding after experiencing differentiated instruction, but I struggle with that explanation. It could be that the question was not valid, but then I wonder if there are others that could also not be valid and it seems from the comparison of collection materials that this is not the case. My instinct tells me that some of my students have just begun to get their curiosity aroused, and time will tell because I have become convinced that differentiation works for students and fits with my style of teaching well.

Differentiating instruction requires much planning and throughout the process my stress level was high. My recorded stress level in my journal was taken on a 4 point scale and rarely did it drop below 2 (4 being the most stressed). I truly believe that differentiation is important for me to be a successful teacher and engage and excite students, but I do not think I could structure all my classes the way I did for this treatment year round. Perhaps the most stressful aspect of the entire treatment was the fact that I was continually questioning myself. Was I meeting my students' needs? How did I know if these activities and lessons were truly targeting individual student's strengths? Would I have enough data to show any significant impact? How would I know if it is significant? I think this is a common occurrence for any one undertaking this kind of differentiation and associated research. Additionally, some students during the interview process also suggested that this type of interaction in large classroom settings can be

more difficult for teachers to manage and thus, harder for students to concentrate during class. Cody said, "…there were times when the class was pretty loud" (student interview #2, 2/19/07, p.2). Susan added, "…it was a little confusing sometimes doing something different from everyone else" (student interview #2, 2/19/07, pg.1). These issues need to be addressed in the future in my classroom.

For the most part it was clear to me during my treatment that students were excited to be part of my research and that they couldn't believe that I could somehow change the way I taught. After evaluating all the surveys and creating specific lessons for each of them, many of them began asking me about my data collection strategies. At the beginning most of them thought that they were going to have to take some kind of test to prove to me that my changes had helped, but after some discussion of qualitative vs. quantitative data, some of them began to see how it was possible. I shared the data collected with my students and they came to the same conclusion that I have: the data clearly points to the fact that students have been more motivated to transfer science knowledge to their lives outside of school than before and that differentiating my instruction was a primary factor in that shift. Perhaps the best part of my entire action research project has been this interaction with students and their interest in the results of their learning. This experience is one that has made me a better teacher and I think that the data cannot refute it.

Value

This action research process has been one of the most valuable undertakings of my life. As I learn more about the process of learning and knowledge attainment my students will find more and more success. I now wonder how I can make this process

more streamlined and fluid within all my classes. The belief that individuals need a unique learning process and gain the knowledge and understanding in new ways is now a part of my concept of an educator and part of my personal teaching philosophy. Perhaps the most valuable outcome of this research has been the positive impact I have witnessed with my students. Because they were fully aware that I was attempting to change something for the benefit of them and future students, their respect for me seemed to grow. I was not just some crusty old science teacher, but I was a caring, dynamic learner too.

This information has implications to my life that extend beyond school. I have two young children and this knowledge has truly helped me appreciate their differences in learning and focused my support towards their styles and needs. I have become more aware of how adults fit these styles as well and have begun to see how some of these styles play out in our interactions. I think it has made me more aware of others around me and able to more accurately show empathy.

This research also has implications that far outreach my personal experience. All educators could benefit from utilizing these practices, and all students would benefit from a differentiated approach; opportunities increase, chances for success increase, and students begin to understand what they are good at and how they should tackle challenges. It can be difficult for educators to meet every students needs, but there are simple ways that classroom activities can be differentiated. Instead of creating individualized activities for each student, create a couple activities for each objective that target different learning styles or intelligence modalities. Done frequently enough and systematically, students will only benefit and educating becomes more enjoyable and

"life-like". I have seen the benefits first-hand and will continue to differentiate my instruction as completely as I can.

References

Cohen, E.G., & Lotan, R.A. (Eds.). (1997). Working for equity in heterogeneous classrooms: Sociological theory in practice. New York: Teachers College Press.

Cohen, E.G., Lotan, R.A., Scarloss, B.A., & Arellano, A.R. (1999). Complex Instruction: Equity in Cooperative Learning Classrooms. Theory into Practice., 38(2), pp. 80-86

Gardner, H. (1995). Leading Minds. New York: Basic Books

Gardner, Howard (1993) Frames of Mind: The theory of multiple intelligences. Fontana Press.

McNiff, J., Lomax, P., & Whitehead, J. (2003). You and your action research project (2nd ed.). London: Routledge and Falmer.

Skowron, J. (2001). How to differentiate instruction. Adapted from Ch. 3 of Powerful lesson planning models: The art of 1,000 decisions. Arlington Heights: Skylight

Sternberg, R.J., (1997). What Does it Mean to be Smart? Educational Leadership. 54 (6), pp. 20-24

Sternberg, R.J., Wagner, R.K., Williams, W.M, & Horvath, J.A. (1995). Testing Common Sense. American Psychologist. 50(11), pp. 912-927

Tomlinson, C.A. (1999). The differentiated classroom: Responding to the needs of all learners. Alexandria, VA: Association for Supervision and Curriculum Development

Tomlinson, C. A. (2000). Differentiation of instruction in the elementary grades, ERIC Digest. ERIC Document Reproduction Service No. ED 457 142

Tomlinson, Carol Ann. (2001) How to Differentiate Instruction in Mixed Ability Classrooms. Association for Supervision and Curriculum Development.

Appendices

Appendix A: Student Interviews

Pre-Treatment Student Interview (Interview #1, 11/29/06)

Interview Question	Negative Response	Neutral Response	Positive Response	Outstanding Response
How are you doing in Science right now?	"Not too good."		"Pretty well." "Good."	"Great."
Do you think about science outside school much?	"No."	"Every now and then." "Sometimes."	"More now than last year."	
Does the way I teach make science more interesting for you?	"Not really, but I just don't like school very much."	"Sometimes, but then there are times when I just want to do something else, like read my book."	"I really like all the hands-on labs you have us do." "Your Power-Points are cool."	
What are some things I could do to help you connect to the world around you?	"I don't know. I really can't think of any." (this response came after some probing)	"Bring in some interesting things to play with and experiment with."	"Let's take a field trip to Glacier! If we helped you plan it do you think we could?"	"We could do some research that is important to our community and present our findings to the public."
What lesson in science really sticks out in your mind? What was it about that lesson that made is stand out?			"The Bacteria Lab, because we actually were testing something real that everybody in school wants to know." "I liked the Atoms Family song. It was funny." "The Bacteria Lab. It was cool that we got use the Bunsen burners."	"The rust and aluminum reaction experiment because it helped me understand what a balanced equation is all about."
What types of things could we do to make all the lessons stand out like those?		"We could have snacks in class and make it a special day."	"Make every class an experiment" "Maybe we could bring in more guest speakers or watch some movies or something like that."	"The students could start their own experiments and you could help us with some of the scientific theories and procedures."

Post-Treatment Student Interview (Interview #2, 2/19/07)

Interview Question	Negative Response	Neutral Response	Positive Response	Outstanding Response
What have you noticed about your learning during the past quarter in science?		"I did most of my work."	"We've done some different things that were interesting to me." "I thought this quarter was much easier than the last quarter."	"It was more fun for me to learn."
When you were learning science this quarter, what did you notice?	"Nothing."		"I think I learned more this quarter." "It was interesting to see what everyone was working on."	"Everyone seemed to understand the ideas better, but there were times when the class was pretty loud."
Is there anything that we have been doing in class that sticks out in your mind as different? Anything that you would like to see in other classes? What are your thoughts about this?		"People did different things. I guess it was okay… sometimes confusing, but good." "There were times when I was confused about how you were going to grade us."	"This class has been great. We do interesting things everyday. Are other teachers going to do more like this?" "All classes should use groups the way we did. It helped and was fun"	"We all had our own tasks and skill to work with, but we were all trying to get to the same place…it was interesting to see how it worked. I think it helped most people."
What have you noticed about your science understanding when you leave school?		"I watch more science programs on TV than I used to."	"I try and share to complete the Scientific Circle of Logic, but sometimes I forget." "I think about what we are learning almost everyday when I walk home." (This student has science at the end of the day.)	"My parents and I discuss issues that we are learning in science almost every day. It's fun, I enjoy it."
What suggestions do you have for me if I teach another class like I did this past quarter?	"I don't know. Maybe blow up more stuff or something else with fire for those of us who like that sort of thing."	"Definitely keep laughing. You make class fun. I think your class would be good with or without differentiated instruction."	"I think that you should try and differentiate all your classes just a little. It seemed to help us and was pretty interesting even though it was a little confusing sometimes doing something different from everyone else." "It's only fair to let every student know what works for their brain and then teach that brain."	

			"I think some of the assignments were too easy, while others were too difficult… so try to make them more even."	

Appendix B: Student Surveys

The initial survey was administered on November 2nd, 2006. The results (in red) represent the total number of responses. Seventy two students completed the survey. The follow-up survey was administered on February 5th, 2007. The results (in blue) represent the total number of responses and the average scaled score.

Please read the following statements and identify whether you agree or disagree. Use the following scale:

5 I completely agree with this statement
4 I somewhat agree with this statement
3 I neither agree nor disagree with this statement
2 I somewhat disagree with this statement
1 I completely disagree with this statement

I have struggled in science class in the past.

1	2	3	4	5			
15	10	26	12	10	Averages:	2.91	
12	12	24	27	21		4.46	Change: +1.55

I am currently struggling in science class.

1	2	3	4	5		
28	33	2	8	2	1.92	
5	2	10	35	20	2.51	+.59

I learn better outside of school.

1	2	3	4	5		
12	15	3	22	21	3.43	
16	15	8	31	2	2.83	-.60

I think that teachers have done a good job of teaching to my interests in the past.

1	2	3	4	5		
20	14	13	20	6	2.68	
25	20	10	12	5	2.40	-.28

I think teachers should focus more attention on my interests when planning lessons.

1	2	3	4	5		
0	1	10	20	43	4.54	
0	0	1	2	69	4.94	+.40

I wish teachers would address my individual learning styles more frequently.

1	2	3	4	5		
0	0	1	8	63	4.81	
0	0	0	5	67	4.93	+.12

I think I am better at learning science than other subjects.

1	2	3	4	5		
10	8	17	30	8	3.29	
11	6	14	22	19	3.44	+.15

When I am away from school I think about things I have learned in science.

1	2	3	4	5		
2	28	25	15	3	2.45	
0	1	14	44	13	3.96	+1.51

I understand how science is important to life outside of school.

1	2	3	4	5	
5	5	24	11	6	2.24

0	2	18	14	38	4.22	+1.98

I can easily recognize what kinds of assignments I will be good at in science.

1	2	3	4	5		
2	3	2	30	35	4.29	
1	0	3	19	49	4.59	+.30

I learn more in science now than I have before.

1	2	3	4	5		
5	2	28	27	8	3.35	
1	0	0	60	11	4.11	+.76

The activities we do in science help me understand the concepts that I am learning.

1	2	3	4	5		
6	4	11	35	17	3.78	
1	0	6	14	51	4.65	+.87

I am successful in science class.

1	2	3	4	5		
10	14	22	20	7	3.04	
4	0	15	17	36	4.13	+1.09

I would like to be more successful in science class.

1	2	3	4	5		
4	4	13	33	19	3.86	
1	0	3	60	8	4.02	+.16

I understand how differentiated instruction can help students learn.

1	2	3	4	5		
15	11	28	10	9	2.86	
2	1	5	38	26	4.18	+1.32

I think that differentiated instruction has helped me learn in science class.

1	2	3	4	5		
15	8	27	23	0	2.83	
0	1	3	7	61	4.78	+1.95

I can identify my learning style as predominantly auditory, visual, kinesthetic or some combination of the three.

1	2	3	4	5		
12	5	14	28	3	2.65	
0	0	0	0	72	5.00	+2.35

I can identify my intelligence modality

1	2	3	4	5		
19	30	5	19	0	2.36	
1	1	0	15	55	4.68	+2.32

It would be helpful if all my teachers used differentiated instruction.

1	2	3	4	5		
2	5	7	50	9	3.86	
1	2	0	16	53	4.58	+.72

Differentiated instruction has helped me make connections to science outside of school.

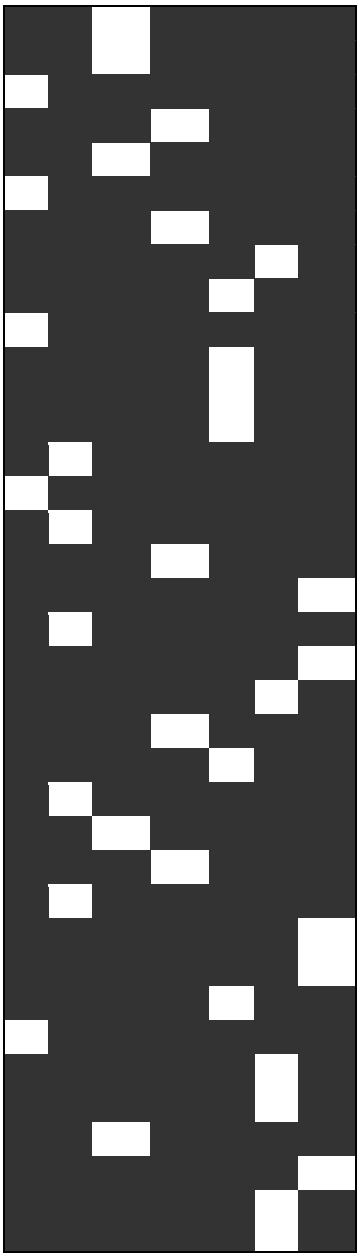
1	2	3	4	5		
8	26	37	2	0	2.49	
3	5	20	28	16	3.68	+1.19

Appendix C: Intelligence Survey

Students were given this survey on November 30th.

1 = Mostly Disagree
2 = Slightly Disagree
3 = Slightly Agree
4 = Mostly Agree

I can play a musical instrument
I often have a song or a piece of music in my head
I find it easy to make up stories
I have always been physically coordinated (run, jump, balance)
Music is very important to me
I am good at making up excuses
I play a sport or dance
I am a very social persona and like to be with other people
I find graphs, charts and diagrams easy to understand
I find it easy to remember quotes, phrases, poems or songs
I can always recognize places I have been, even when I was little
When I am concentrating I tend to doodle
I find mental math easy
At school my favorite subject is English
I like to think through problems carefully
I love adrenaline sports and scary rides
I enjoy individual sports best
I find it easy to remember telephone numbers
I set myself goals and plans for the future
I can tell easily whether someone likes me or not
To learn something new, I just go out and try it
I often see clear images when I close my eyes
I don't use my fingers when I count
At school I love music lessons
I find ball games easy and enjoyable
My favorite subject at school is math
I always know how I am feeling
I keep a diary
My favorite subject at school is art
I really enjoy reading
It upsets me to see someone cry and not be able to help
I prefer team sports
Singing make me happy
I am happy spending time alone
My friends always come to me for emotional support and advice



Intelligence Type	TOTAL %
Linguistic	9
Logical/Math	7
Musical	15
Kinesthetic	43
Visual	6
Interpersonal	4
Intrapersonal	16

Appendix D: Learning Style Survey

Students were given this survey on November 30th.

Score the statements:
1 = Mostly Disagree
2 = Slightly Disagree
3 = Slightly Agree
4 = Mostly Agree

Score each statement using the scale above, and then total each section.
_____I can remember something better if I write it down.
_____I am able to visualize pictures in my head.
_____I take lots of notes on what I read and hear.
_____It helps me to LOOK at a person speaking. It keeps me focused.
_____It's hard for me to understand what a person is saying when there is background noise.
_____It's easier for me to get work done in a quiet place.
_____It's easy for me to understand maps, charts and graphs.
_____When I am concentrating on reading or writing, the radio bothers me.
_____When taking a test, I can "see" the textbook page and the correct answer on it.
_____I cannot remember a joke long enough to tell it later.
_____When I try to remember something new like a telephone number, it helps me to form a picture in my head.
_____When I get a great idea, I must write it down right away or I'll forget it.
_____=Total for Visual Learner

_____When reading, I listen to the words in my head or I read aloud.
_____I need to discuss things to understand them better.
_____I prefer having someone tell me how to do something rather than read the directions myself.
_____I prefer hearing a lecture or tape rather than reading a textbook.
_____I remember what people say better than what they look like.
_____I can easily follow a speaker, even though my head is down on the desk or I'm staring out the window.
_____I remember things better if I study aloud with someone.
_____It's hard for me to picture things in my head.
_____I find it helpful to talk myself through my homework assignments.
_____When learning something new, I prefer to listen to information on it. Then read about it. Then do it.
_____I like to complete one task before starting another.
_____For extra credit, I prefer to do a report on tape rather than to write it.
_____=Total for Auditory Learner

_____I don’t like to read or listen to directions: I’d rather just start doing.
_____I can study better when music is playing.
_____I need frequent breaks when studying.
_____I think better when I have the freedom to move around, studying at a desk is not for me.
_____When I can’t think of a specific word, I use my hands a lot and call something a “what-cha-ma-call-it”.
_____When beginning an article or book, I prefer to take a peek at the ending.
_____I take notes, but never go back to read them.
_____My notebook and desk may look messy, but I know where my things are.
_____I use my fingers to count and move my lips when I read.
_____I dislike proofreading my work.
_____I daydream in class.
_____For extra credit, I’d rather create a project than write a report.
_____=Total for Kinesthetic Learner

Appendix E: Student Interest Inventory

Students were given this Survey on November 30th.

1. What do you like to do after school?
2. What are your special interests besides subjects learned in school (sports, music, hobbies, etc.)?
3. If you had three wishes, what would they be?
4. If you had to choose one class to attend all day which one would it be, why?
5. Do you like to read? Why or why not?
6. Do you have any books at home?
7. Do you consider yourself a writer? Why or why not?
8. What do you think makes a good writer?
9. Do you consider yourself a scientist? Why or why not?
10. If you had to stay in one location for the rest of your life and could not move to a new town, where would that place be? Why?
11. If you could choose any job for your future what would it be? Why?

Appendix F: Text-Based Analysis Procedures

Text-based data analysis will occur with interviews, videos, and some survey questions. The process of evaluating this data is explained in a step-by-step procedure. In order to keep the focus question central, all available data will be considered and any relevant data included.

1. Review my research question. Keep this as a focal point throughout the analysis, this will be written at the top of each category sheet.

2. Read through all the transcribed data as if it were a conversation.

3. Re-read transcribed data, highlighting text that pertains to focus question (evidence either for or against). Be thinking about categorizing this data.

4. Re-read transcribed data with the intention of cutting and pasting highlighted text into categories. Write the research question at the top of multiple sheets of paper. Physically cut out text and place them into appropriate categories which will be determined as they manifest. Take notes on any obvious evidence or tendency within the categories.

5. Re-read all transcribed data and make sure that there is nothing missing that should be included into a category. Add any to their appropriate category sheets.

6. Create a concept-map of categories centered on the focus question. Write a simple paragraph explaining the relationships in the concept map.

7. Summarize the evidence using examples and include connections to other types of data collection and future considerations.

8. Share these findings with my mentor.

9. Revise.

10. Write.

Appendix G: Student Created Example

Skit dealing with Force and Motion

Inertia is Boss!

Cast:
Inertia – Stuck in her ways
Force – Very demanding

Inertia is hanging around the playground looking cool and content when Force approaches to start a conversation.

Inertia: I am inertia, master of the playground, so powerful I don't need to do anything. Everyone else will do it for me. Yessireee, this is the life.

Force: Oh yeah? I'll bet I can make you work, you lazy bum because you are nothing more than unused energy.

Inertia: You know, you are right, you can make me move. But then you'll just have to make me stop because I'll just keep on doing whatever it is I'm doing forever unless you do something about it. You see, I don't care either way if I play, move, or just sit here forever and you will always have to do all my work. Isn't that awesome, what a life I have.

Force: So are you saying that you don't have the ability to make decisions of your own? Isn't there something you have always wanted to do or see that you can't because you rely on me all the time?

Inertia: I can't say there is. I'll just do whatever I happen to be doing forever and ever. It's fun never doing any work.

Force: Well I'm getting kind of sick of having to do all the work, so why don't you buck up and get off you duff and do something for once.

Inertia: Nah! If you want me to do something else, push harder or pull more and then I may go faster or slower, or stop altogether, you'll just have to do it all always and forever.

Force: Oh come on Inertia, just this once give me a hand and help me out. Please?

Inertia: Hmmmm, let me think about that……Nah! What good will it do me? I can't help you out no matter how much you beg. It's not that I don't feel you grief it's just that I truly cannot help you out. So why don't you just take a chill pill and do what you always do and move me or don't…I don't care. You're going to do it forever.