STUDYING THE EFFECTS OF DIFFERENTIATED INSTRUCTION IN THE SCIENCE CLASSROOM

by

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In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

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ABSTRACT

In this investigation differentiation strategies were implemented with the purpose of improving student engagement and learning in both individual and group work settings. Group work activities were differentiated according to learner profile. Though performance on summative assessments did not show marked improvement following the treatment, the students did demonstrate improved formative assessment scores. The students also expressed a more positive attitude with regards to their level of self-confidence in the learning setting. A total of forty eight students from two regular chemistry classes were used as the sample for this study. The following instruments were used as the data collecting source: chapter test scores, percentage of completed homework assignments, student lab reports, student surveys, student interviews, parental surveys, teacher reflective journal, teacher survey, and teacher evaluation by the supervising administrator.

INTRODUCTION AND BACKGROUND

During the 2012-13 school year, I had the pleasure of teaching four different courses at the high school where I work – Central High School in Spring Hill, Florida. These courses included the following: two regular chemistry classes, two physical science classes, one, physics honors class, and one chemistry honors class. I had over 140 students in my roster and many of these students had a very diverse background in terms of prior general science knowledge and study skills. The purpose of my action research project was to find some new method, or methods, of classroom instruction that would help this diverse student population improve their overall performance in the chemistry classroom, as well as their level of confidence and self assurance in the same chemistry classroom.

The student population that has been part of my classroom experience has been quite diverse over the course of the last few years that I have been teaching at Central High. By diverse I am referring to both the demographics and the academic background of my student population. When I first began teaching at this school, I had a far more homogeneous student population within my classroom; in other words, I was able to effectively teach the majority of my student population by implementing a type of “one size fits all” style. Sometime around five years ago, however, I found myself – along with many of my peers – having to teach in a more heterogeneous classroom setting where my former “one size” style was not working well enough. Many of the students were coming to me with a much more diverse background in their prior academic experiences. Changes in the zoning laws in my school district and an overall increase in the number of transient students (probably a result of the changing economy) might have been the cause for this population change. The major challenge that I faced as a result of this change in student population was that I was no longer able to reach all, or even most, of my

students when presenting the course material. I often found that a substantial number of my students were often unable to keep up with the rigorous pace of the course., As a means of dealing with this diverse student population, I have implemented the use of *differentiated instruction* with my regular chemistry students. Differentiated instruction (DI) is a system that provides students with different avenues for acquiring course content so that all the students within a classroom can learn effectively, regardless of differences in ability. I have chosen my regular chemistry classes (periods 1 and 6) for this project, simply because they have the most student diversity of all the classes on my schedule this year. Table 1 below provides a description of these student demographics.

Table 1
Class Demographics, (N = 48)

Class Period	Total Students	Boys	Girls	Free & Reduced Lunch	ESE*
1	24	18	6	10	3
6	24	16	8	11	2

* Exceptional Education Students (ESE) is a term used to identify students who have an individual educational plan (IEP) which would tell the teacher the specific educational accommodations that are mandated by law.

Research Questions:

My primary research question was "What are the effects of differentiated instruction on student performance in a chemistry classroom?" I also had the following sub-questions:

1. How does DI impact student achievement on chemistry assessments?

2. What are the effects of DI on the level of student confidence and self-assurance in a chemistry classroom?

3. What effect will implementing DI in the classroom have on the teacher?

A project of this magnitude could never have been completed without the help of my colleagues at Central High School, and the faculty at Montana State University. I used a variety of school resources to help me accomplish this endeavor. The science department at my school had bi-weekly professional development meetings which were geared toward the application of differentiated instruction in the science classroom. I asked a lot of questions of the more experienced teachers in my department. One of these teachers in particular has over forty years of classroom instruction and is going to retire at the end of this school year. Fortunately, I was able to pick his brain during the spring 2013 semester, and he was indeed a great means of support to me during that time (he did request that I not use his name in my paper, and I did assure him that his anonymity would be preserved – he's a bit funny like that). I also received considerable help from the media center specialist in our school. Dr. Anne Billica had just received her doctorate as a media specialist and she was a very valuable resource in the area of literary review on differentiated instruction. Dr. Billica steered me in the right direction in terms of where I might find some additional resources of information with regards to the DI centered nature of my project.

Overall, this has been a very challenging and rewarding process that I have engaged in during the past five months. I am very fortunate to have had such significant assistance in my endeavors. I truly believe that working through this project has made me and will make me, in times to come, a better teacher – which was really the main goal that I was striving for as I decided to go back to school and start the master's in science education program at MSU over four years ago.

CONCEPTUAL FRAMEWORK

There are many schools in the Tampa Bay area, including my own, that are now implementing the use of differentiated instruction in the classrooms. It is, therefore, no coincidence that much research has been done on this topic. Differentiated instruction provides a framework for modifying curriculum and teaching strategies to complement the knowledge readiness, areas of interest and learning profiles of each student (Tomlinson & Eidson, 2003). The five classroom elements that can be modified are as follows: *content*, *process*, *product*, *learning environment*, and *affect*. Content deals with what is taught and how it is presented; process is the means by which students apply and learn the content. The product, or summative assessments, would show what students have actually learned. The learning environment relates to how time, materials, and space are organized, and affect considers the affective or emotional needs of individuals.

There is definitely a wide range of instructional strategies which may be employed to differentiate classroom elements for student readiness, interest, and learning profile. These strategies should support the following guiding principles of differentiated instruction (Tomlinson, 2003):

- ✓ Learners are respected by providing them with work that focuses on the essential knowledge, understanding, and skills targeted for the lesson.
- ✓ Students are kept intellectually challenged while providing appropriate support so they are successful.
- ✓ Class time includes opportunities for flexible grouping, whole group work and individual work.

- ✓ Assessments are ongoing so differentiation for individuals remains informed and responsive to changes in development.
- ✓ Curriculum is coherent, important, inviting, and thoughtful.

Using differentiation for a learning profile among the five classroom elements begins with an understanding of learning style, intelligence, and culture (Tomlinson & Eidson, 2003; Sternberg, 2006). Once these aspects are pre-assessed, one approach to modifying the process for learning profile is through flexible grouping where students work in groups that have both shared and varied learning profiles. Pre-assessments or assessments that typically occur at the beginning of a learning sequence, can take a variety of formats and can range from being completely separated from the instruction or can simultaneously serve as instruction and assessment. Depending on the purpose, a teacher can use a pre-assessment to:

- ✓ Elicit information about students' readiness to learn skills and concepts;
- ✓ Gather information about students' preferred modes of learning (including learning styles and grouping preferences); and
- ✓ Gather information about students' attitudes about the learning, areas of interest within the study, and initial questions about the learning.

The forms of pre-assessments that I used for my classroom were the pre-quiz, the entrance/exit card, a multiple intelligence self assessment, and a group work attitude survey. The goal of these pre-assessments was to gather as much information about each student's strengths, comforts, or areas of weakness. These activities have hopefully led me to appropriate proper differentiation that accommodated each student's learning needs and preferences throughout the school year, especially when the students were broken up into groups to do an assignment.

Group work activities should be combined with individual, group, and whole class instruction that addresses what went well and what could be improved upon (Johnson & Johnson, 1994; Martin-Kniep, 2000). Each member of a group may do a written reflection on how the team is working together (Willis, 2007). I would at times direct questions to the groups while they are working together. Questions such as, “Is everyone talking and asking questions?” and “Are you listening to one another and explaining your thinking?” helped in guiding group efforts (Cohen, 1994, p. 53). These types of questions can also be incorporated in a group role such as the reflector or “encourager”, or reinforced through guidelines established in advance (Lin, 2006; Parr, 2007). When reflection becomes an ongoing characteristic of group work, the result is increased focus and effectiveness and equal participation of all group members.

One must be cognizant of the fact that any of the tasks which are to be completed in a group setting should be group-worthy (Lotan, 2003). Group-worthy tasks are based on meaningful content and clear assessment criteria for both the group and its individual members. They are framed around open-ended questions or issues that require complex problem-solving applying a range of skills. When students are heterogeneously grouped, an atmosphere of positive interdependence is cultivated where the diverse skills and contributions of every member are valued and considered critical for success (Johnson & Johnson, 1994). The lack of this “group-worthiness” in some situations is perhaps the biggest criticism against group-work that is often mentioned by educators who are opposed to its use. A group could easily lose its worth by simply having one or two of the students within the group do most or all of the assigned work while the rest in the group simply copy the material and gain absolutely nothing from the exercise. The task and implementation of the group work must therefore be framed very carefully in order to maintain its “worthiness.”

The viewpoint that one can take on the use of differentiated instruction is that of a "way of thinking about 'being' that honors and contributes to the uniqueness and the possibilities of each person in the group, as it honors and contributes to the success of the whole" (Tomlinson, 2004a, p.189). Differentiation in the classroom shows that everyone can learn in their own particular way despite any learning style differences. As both teachers and students learn to work together with these differences within the classroom, a more productive and engaging learning environment should be created.

A greater level of student confidence was achieved as a result of the differentiated instruction that was incorporated within my classroom. This was evidenced by the data collected from student surveys, interviews, and exit cards. This data, and its analysis, will be discussed in detail in the Methodology and Data Analysis section of this paper.

METHODOLOGY

During the five month period within the 2012-13 school year that was devoted to data collection. I used what I have come to call "tune-up stations" during the instruction time of my two chemistry classes. This is basically a 10 to 15 minute portion of the class where I separated the students into groups on the basis of their aptitude on certain topics within the class. In addition to the previously mentioned pre-assessments that were implemented to measure the student's varying learning styles, I also used additional means by which I was able to determine whether a student was strong or weak in a certain topic that was being discussed in the class. These other means of student-skill indicators were chapter assessments, section quizzes, and the quality of student lab reports. Once the student groups were determined, I spent most of the tune-up station time circulating from group to group helping each group as much as possible, while

still allowing them to function as a self supporting group. Each of the groups was therefore composed of higher, average, and lower achieving students.

The tune-up station treatment was implemented during a lesson on one of the more important topics covered in my general chemistry class: the writing of chemical formulas. Students, especially the non-science motivated, generally struggle with the fundamental concepts of why chemical formulas are written the way they are. For many simple inorganic compounds, the writing of correct chemical formulas is, in fact, simple, provided a few basic rules are followed. The students used a set of flash cards to model writing names of chemical compounds and writing correct formulas. After the explicit instruction component that introduced the rules and techniques (such as the criss-cross method), some sample problems were done on the board. Furthermore, additional problems were given out as a means of guided practice. After this practice was concluded, I allowed the students to gather into their tune-up station where they could continue the lesson in the group setting. Each station had an assigned number, and I directed the students to the particular station they were to work in. Each station was composed of higher, middle, and lower achieving students. I have included the lesson objectives, evaluation methods, and procedures. They are as follows:

Process Objective(s):

1. Students will demonstrate how to name simple inorganic chemicals by their formulas.
2. Students will successfully write correct formulas for simple inorganic chemicals.

Formative Evaluation:

1. Review previous vocabulary: *atom, electron, molecule, compound, symbols* and *chemical formula*. Students will orally define these terms (If necessary, review the concepts); and be asked if they know what is a *subscript*, *superscript* and *radical*, and can give an example of each.

Summative Evaluation:

1. A written assessment will be given after lesson, for example, “Name this compound” after showing formula; “Write the formula for this compound” after giving its name; and “Is this formula correct?” after showing its formula.

2. An extended project will require each student to find five (5) household products that contain a simple inorganic compound, hand in their labels (or a reasonable facsimile), name the compound and write its chemical formula.

Procedures:

1. Show an example of a chemical formula. Ask the following: “What is the name of this compound?”**,** “Can you tell if this formula is correct?”, and “How can you tell if the formula is correct?”

2. Tell students that we will come back to these examples at the end of the lesson to see if they answered/guessed correctly.

3. Introduce new vocabulary: *subscript, superscript,* and *radical, and* explain how they “work”.

Explore:

1. Distribute ion flash card sheets and review and explain the symbols used. Be sure students notice and understand the charge symbol in the upper right hand corner of each ion. Ask which numbers are the superscripts and/or subscripts. This was the point at which the lesson was stopped at the end of the first day.

2. Distribute scissors, rulers and envelopes. Have the students cut out the cards; and identify the envelope with their name and class information.

3. Have the students arrange the cards in vertical rows, by charge, starting with hydrogen. Ask, “What does the arrangement resemble?”

4. Naming chemical compounds: Ask the students to name several compounds by showing their formulas. This is easily done by the students finding the appropriate flash cards and reading the names of the ions directly from the cards. The students were able to complete this portion of the lesson in their tune-up stations by the end of the second day.

Explain:

1. Use the appropriate vocabulary about chemical formulas to explain what we did and why we did it.

Elaborate:

1. Show how a correctly written formula is electrically balanced.

2. Remind students that what we did applies only too simple compounds and there are more complex inorganic compounds and formulas that have some other rules to follow.

This particular lesson affords the students numerous opportunities to work in a group setting, such as the tune-up stations, that I have incorporated into this project. Within these stations, I have also placed students who I felt were particularly strong in the topic that the group was working on (chemical formulas, for example) with the struggling students so that they would be best able to help each other. These tune-up stations, which were a major component of my differentiated instruction, have allowed me to reach the various students at their own level of content mastery for a given unit. I used these stations twice a week (Tuesday and Thursday) for twenty minutes each day. The use of these stations would probably have been even more effective if they could have been used on a daily manner, but doing so would not have allowed the necessary time to dispense the subject material.

One cannot forget that there is a very time sensitive “pacing-guide” that is used in my school for all of the academic subjects, of which chemistry is certainly one. As a result of the

need to keep up with the pacing-guide, I was somewhat limited to the amount of time that I could spend on the tune-up stations. As it turned out, I spent the second marking period implementing my instruments, such as the tune-up stations, and collecting all of my data. This second marking period took place from October 8th through December 17th of the school year's fall semester. This time period amounted to a total of forty class days in which the differentiated instruction was used with my two chemistry classes. The student baseline data used for comparison was obtained during the first marking period (August 20th through October 5th) of the school year.

In order to gather data for sub-questions #1-3, I used a number of data collecting instruments throughout the fall semester with my regular chemistry classes. There was a total of nine data collecting instruments in this action research project – three for each of the sub-questions. It is my belief that with the three sub-questions answered, I was able to properly answer the primary question. The following table shows the data collecting instruments for each corresponding sub-question.

Table 2
Data Collecting Instruments

Question	Data Source # 1	Data Source # 2	Data Source # 3
How does DI impact student achievement on chemistry assessments?	Chapter Test Scores	Percentage of completed homework assignments.	Student Lab Reports
What are the effects of DI on the student level of confidence and self assurance?	Student Surveys	Student Interviews	Parental Surveys
What effect will implementing DI in the classroom have on the teacher?	Reflective Journal	Science Department Teacher Survey	Teacher Evaluation by the Supervising Administrator

In order to answer sub-question number # 1 – "how does DI impact student achievement on chemistry assessments? – I was able to simply use the usual classroom assessments, homework assignments, and lab reports as a means of a measuring tool. The results of these measuring devices will be discussed in detail in the next section of the report.

For this capstone project I used the Likert Survey to measure the level of student confidence and self assurance. I have chosen the Likert survey to address my sub-question # 2 on student confidence and self-assurance since this was a recommended technique that I read about in the Geoffrey Mills book *Action Research: A Guide for the Teacher Researcher* (2007). Mills states that an "attitude scale" allows a researcher to determine what students believe and feel. As previously stated, I have chosen my 1st and 6th periods, which are my regular chemistry classes, as my action research subjects. I have chosen this particular group of students because they represent my most diverse student population. I administered the surveys at the middle of the second marking period, and again toward the end of the same marking period. The survey can be found in the appendix to this report (Appendix A).

A set of student interviews also addressed the same sub-question # 2 "What are the effects of DI on the student level of confidence and self assurance?" The interviews were performed twice during the second marking period, soon after the surveys were filled out. I chose nine students from each period who are high performing students, average performing students and underperforming student (three students from each performance level were randomly selected). I also interviewed one male, one female, and one free/reduced lunch student (male or female) for each sub-group. I believe that these types of student samples provided the results that were well in line with my classroom demographics.

To facilitate an answer to sub-question # 3 - “what effect will implementing DI in the classroom have on the teacher?” I kept a reflective teacher journal throughout the duration of the project. By using this journal, in which I tried to make entries at least three times a week towards the end of the workday, I was able to evaluate how this entire process of incorporating differentiated instruction in my classroom affected my overall educator and personal disposition throughout the length of the project. Of course, this journal would only help me to evaluate the effects of DI on my own personal teaching experiences. I therefore also created a simple teacher survey (see Appendix C) which I passed out to a dozen other teachers within my own school, and also within the school district, to see how using DI might have affected them. The majority response to this survey and to the experience of employing differentiated instruction was actually not very different from my own experiences (discussed in the next section).

The data gathered to answer sub-question # 3 also includes the final annual teacher evaluation, for which I can gladly state that I have thus far achieved a “highly effective” status. Our school district (Hernando County) uses the following grading scheme in order to evaluate its teachers: ineffective; needs improvement; effective; highly effective.

The reason as to why I stated that I had “thus far” received a highly effective rating is due to the evaluation system being presently employed by my school district. The actual teacher evaluation is presently broken down into a 50/50 system, where one half of the teacher’s “grade” comes from classroom observations, lesson plans, teaching strategies, knowledge of subject matter, classroom professionalism, and other factors which are directly related to the actual teacher performance. In this component of my annual evaluation, as previously mentioned, I received a “highly effective” grade. The other 50% of the teacher grades comes from student performance in certain district and state examinations. It is a very heated aspect of the teacher

evaluation process in the state of Florida (as well as in other states, I believe), since some teachers are being evaluated on the assessment performance of some students that they have never even taught.

Unfortunately, I do not have access to the data that provides the identity of the group of students that determines the other half of my evaluation. I can say, however, that my immediate supervisor who did the “classroom” portion of my evaluation was very pleased with the use of differentiated instruction in my class. I am quite certain that using differentiated instruction is the wave of the future both in my school and most likely in the district as well. I feel as though I have a very nice advantage now as a result of this capstone project, and I am very grateful for the opportunity to take part in it. My high school would not grant me the permission to include a copy of the teacher evaluation instrument in my paper, so I am unable to provide it in the appendices section.

In order to help insure the validity and reliability of my chosen instruments, I have picked three separate instruments for each of the sub-questions. This was done in order to have three separate sources of qualitative and quantitative data for each question and, thus, triangulate the collected information. All of the research done by myself with my two chemistry classes received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained during Fall 2012. I have included a copy of the IRB exemption form in the appendix section of this paper (Appendix B).

DATA ANALYSIS

Data analysis has been performed throughout the second marking period on all nine instruments mentioned in the methodology section of this report (see table 2). I will break down

the data analysis in a systematic fashion working my way through all of the instruments as they pertain to each of the three sub-questions: # 1 *How does DI impact student achievement on chemistry assessments?;* # 2 *What are the effects of DI on the level of student confidence and self-assurance in a chemistry classroom?;* #3 *what effect will implementing DI in the classroom have on the teacher?* By answering these three questions, the primary focus question - *What are the effects of differentiated instruction on student performance in a chemistry classroom?* - would also be answered.

Sub-question # 1

The data collected as a means of answering this question on achievement in the chemistry classroom was compiled from three separate chapter tests that were given during the second marking period, along with six homework assignments, and finally, four lab reports that were written on each of four separate labs that were done by the students during the same time period. The results of the student level of performance for these three parameters were compared with the same number of activities from the first and third marking periods – in which differentiated instruction was not applied to the lessons. The following table shows the comparable results of test scores, homework completion rate, and lab report write-up proficiency.

Table 3
Student Performance With and Without DI (N = 48*)*

Activity	With Differentiated Instruction	Without Differentiated Instruction
Test Score Average	68%	67%
Homework Completion	89% completion 43/48 completed HW	78% completion 37/48 completed HW
Lab Reports	average grade = 86%	average grade = 74%

Data table 3 shows that the student's test scores did not change significantly from the implementation of differentiated instruction. This was a bit of a disappointment to me since I was hoping that the tune-up stations would have a more positive result on the academic component of the student's profile. However, this might only indicate that the use of a treatment for one quarter of the school year did not allow enough time to make a noticeable impact on student performance.

The chapter test scores did increase by a 1% margin with the application of the differentiated instruction; nevertheless, I would not classify that percentage as a noticeable improvement on the test scores. The classroom procedure that leads up to the assessment component for a particular unit is known as "gradual release". This process involves the implementation of *explicit instruction, modeled instruction, guided practice, checks for understanding*, and *independent practice*. In the explicit component of the lesson the teacher would introduce and explain any new concepts, new vocabulary, and mathematical applications. Modeling would follow the explicit instruction as a means of showing the student how to perform any calculations or better understand a difficult concept. This is where sample problems would be broken down step by step on the board. The modeled instruction would then be followed by the guided practice component. This is a nice opportunity for the students to work out any practice problems or answer any of the review questions that come from the textbook or some sort of worksheet – with the help of the instructor. After some guided practice comes the independent practice is the time, which is a time for the students to do more practice work on their own, usually at home, on some type of homework assignment.

Throughout this process, there is also some type of periodic "checks for understanding". This is a component which is used in a lesson as often as possible. I may ask an appropriate

question on a given topic, or sometimes use response cards for multiple choice types of questions. The point here is to avoid moving on with a lesson if too many of the students are not getting the main idea. Being that the purpose of independent practice is for the student to work autonomously, I did not incorporate differentiated instruction in this component of the gradual release model. I did, however, incorporate both the exit cards and the tune-up stations during the modeled instruction and guided practice component of each lesson.

It was my hope that the student performance, as measured by end of unit assessments, would have shown a larger improvement for this quarter of the school year. As previously noted, the implementation of DI during part of the gradual release model may have shown a more noticeable improvement on student performance had it been used during the entire school year, instead of just during one quarter of the year.

The homework completion and its level of quality – measured by simply calculating the number of correct answers per assignment, did increase considerably with the use of DI. Although the homework assignments were usually completed at home, the students were encouraged to work on "some" of the problems and questions during their "tune-up" time. It appears that this application of DI was a significant helping factor in the completion and, more importantly, the understanding of the assignment. It is for this reason, that I really expected the test scores to show a more pronounced improvement than they actually did. I do not believe that some of the students were simply copying off the other students and turning in that work (as one of my colleagues suggested). I only say this because I spent a considerable amount of time during the DI time circulating amongst all of the work stations, and I can honestly say that I did not see any copying of the answers by the students. Nevertheless, the total amount of time that

was spent on the implementation of DI – one marking period – may not have been sufficient to achieve the desired results in the student assessments.

The lab component of a chemistry class – or any science class, for that matter – is an enormous component of the learning cycle for the student. This is where the "rubber meet the road", as they say. Lessons on the conceptual aspect of chemistry are all well and good for the student as a means of absorbing and synthesizing the content matter; however, there has to be some type of practical application in order to really grab the student's attention and nurture their curiosity. There is usually some sort of class demo at the beginning of every new topic for that very same reason – enhance the student's curiosity. The grading scheme for a lab will consist of 50% lab work done in the lab itself, and 50% for a written lab report. The students get a lab report rubric at the beginning of the year and I spend considerable time explaining how the writing process works. I always try to emphasize the importance of accurate and truthful data and observations. Being a former analytical chemist in New York City before I decided to get into teaching, I usually will give my students an interesting anecdote about something to do with lab journal recording accuracy and neatness (like never to use "white-out" when correcting an entry in the journal, as one of my colleagues at the lab discovered during an audit of the lab's books).

I was very pleased to see that the quality of the written lab reports improved considerably (the average grade improved from a 74% C to an 86% B) as a result of the implementation of differentiated instruction. Because all other parameters of my class remained unchanged, it is quite possible that the improved lab report grades are a direct result of the tune-up stations. I did observe during my circulation time with the tune-up stations (more on these observations will be noted in the "reflective journal" portion of this report), that many of the top performing students were genuinely helping out the students who were having a difficult time with the reports. This

was noted in one of my journal entries from November 9th, "The students are working very well together in their stations. I'm really pleased with the amount of time and effort that my top students are putting in to help out those who are struggling."

It was a very encouraging sign to see in my class, especially as there were less need for my help in many of the stations as the research period wore on. The students who normally struggled with their assignments were beginning to become more self-sufficient within the confines of their group.

Sub-question # 2

The second sub-question in my research addressed the confidence level and self-assurance of the typical high school science student. There were three data collecting instruments designed to help answer this question: a student survey, a student interview, and finally, a parental survey. I must state that the parental survey was not very helpful in formulating any kind of a clear-cut answer to this question due to the fact that only 19% of the parents (nine out of forty eight) actually returned their completed surveys . This noticeable apathy was a bit discouraging and alarming at the same time. The parents were given an entire two weeks to complete the rather simple and short survey, yet only a handful of them actually accomplished this task. Perhaps an additional research project and paper on increasing parental involvement in a child's education should be written by a future MSSE candidate. As a result of this rather unfortunate situation, I am limited to using only the student surveys and the student interviews as an appropriate instrument to determine if differentiated instruction did indeed help to build up a chemistry student's confidence and self-assurance level. It should be noted, however, that the parents who did turn in their surveys, were the parents of the top performing students in my class. This really did not come as a major surprise being that the same sort of pattern is seen

during the open-house days we have at my school. On those days, it is usually the parents of those students who are excelling in my class that will show up. The parents who I really needed to see and talk to were no-shows.

The student survey was completed after students took their end of chapter summative assessment on the development of the atomic model. For each question on the survey, student responses were quantified with 1 being *strongly disagree* and 4 being *strongly agree*.

For the individual student interviews, nine students were individually interviewed upon completion of the same chapter on the atomic model. The students were selected from the two class periods according to their achievement level in my classes. Three low performing students were interviewed along with three average performing students and three high performing students. The nine students from these diverse performance levels were all randomly selected. Interviews were conducted during my planning period in the school's media center. Parental consent was obtained before the interviews were conducted, but an exemption form would have to be filled out by the school's principal before any other interviews could be conducted. As it turned out, it was quite time consuming to get those parental permission forms filled out.

On the Likert student survey, the 17 questions pertained to four categories: attitudes towards school, attitudes towards chemistry class, confidence towards chemistry class and attitudes towards chemistry class activities. The survey was conducted after the treatments were implemented. Table 3 summarizes the average score for each category of the student survey.

Table 4
Average Scores per Category from Student Likert Survey, (N = 48)

Category	Average Score
Attitudes Towards School (Questions 1, 2 and 5)	3.5
Attitudes Towards Chemistry Class (Questions 3, 4, 6, 10)	3.4
Confidence Towards Chemistry (Questions 7,15,16,17)	3.2
Attitudes Towards Class Activities in General (Questions 8,9, 14)	3.4
Attitudes Towards Review Activities (Question 11)	3.2
Attitude Towards Lab Activities (Question 12)	2.8
Attitude Towards Review Activities (Question 14)	2.6

Students had an overall positive attitude towards school with only eight of the 47 students surveyed receiving a score below a three. Students also had an overall positive confidence rating for chemistry class. In comparing student attitudes towards chemistry class and student confidence levels towards chemistry in general, 62% of the students had a more positive response to the confidence questions than towards questions regarding chemistry class. As the research project progressed throughout the second marking period, I continued to notice a far more positive attitude from many of the students in my two chemistry classes. As noted in my reflective journal, “even the usual cast of under-achieving students is starting to get a bit more engaged in the class work.” This was such a noticeable change that I was almost tempted to continue the implementation of the differentiated instruction throughout the school year. Upon

ending the DI during the second semester (third and fourth marking periods) I did also notice that many of the students were disappointed in the fact that I was no longer using the tune-up stations. This was noted in some of the interview responses: “I would love to see more teachers use those group stations for review”; “the stations really help me in learning the material, especially when I have to teach it to one of my classmates”; “the group work makes the class much easier for me to manage.”

Unfortunately, I did not have the students fill out this survey prior to the treatments. That is a real shame, since it would have given me a pre and post treatment comparison of the survey results. Nonetheless, I am still very pleased with the positive attitude that the students showed in the post-treatment survey.

Overall students responded positively to the questions regarding student activities. When asked if chemistry is boring, only three students agreed with that statement with zero students strongly disagreeing. Only four students disagreed with the statement “The activities we do in chemistry help me learn” while 17 students strongly agreed with that statement. The activity that the students responded the most negatively to was the review activities. I believe that the reason for this student reaction might be because these review activities are usually right before the actual test and the review just reminds the students of the upcoming test. I suppose that perhaps “test anxiety” might be the underlying reason for the negativity towards test review activities. On the other hand, however, the students responded the most positively to the statement, “I enjoy the lab part of chemistry activities.” I was not really surprised by this respond from the students. As stated previously in this paper, lab activities and demonstrations are a great way to get the student’s curiosity level at its peak. The class thoroughly enjoys when things go “bam” or “poof” or change colors, etc. in the lab (under controlled conditions, of course). I usually do at least one

demo per week in all of my classes (a major time commitment – but well worth it). The students will do a lab every two weeks on average. The labs will usually take about two class periods per lab including the set-up and clean up time.

Numerous interviews responses have indicated that having the lab groups set up in the same fashion as the tune-up stations have made the lab experience far more enjoyable. “Much better labs now that at least someone in the group knows what they’re doing”; “at first I wasn’t crazy about having to work with certain classmates, but now it really seems to working out. I don’t mind explaining things to others, even if they weren’t paying attention when Mr. Rojo was explaining the procedure. Explaining it to others helps me to better understand the procedure myself”; “labs were good, but with these new groups they are much better!”

Students’ responses from the individual student interviews support the findings from the Likert student survey. The ten questions from the individual interviews were grouped into three categories; attitudes towards science class, attitudes towards class activities, and attitudes towards learning. Table 5 provides a summary of responses for each question grouped by category.

Table 5
Interview Question Category and Summary of Responses (N = 9)

Interview Sub Category	Interview Question	Summary of Responses
Students' attitudes towards chemistry class	**1**. Do you like school? **2**. Do you find chemistry in general interesting? **3**. Do you like chemistry class? **4**. If you could choose 2 words to describe chemistry what would they be?	**1**. 8 responded "yes" and 1 responded "sometimes". **2**. 7 responded "yes", while 2 responded "only when we do labs". **3**. All 9 responded positively. **4.** 4 said "interesting", 3 responded with "cool", and 2 others responded with "weird."
Students' attitudes towards class activities	**5**. What are some activities that we do in chemistry class that you like? **6.** What are some activities that we do in chemistry class you are the least comfortable with or do you like the least?	**5**. 4 students said "lab activities", 3 students said "demos", and 2 students said "computer lab". **6**. 5 students said "writing notes" and 4 students said "taking tests".
Students' attitudes towards learning	**7**. Do you feel like you know what is going on in chemistry class? **8**. Do you feel you are able to successfully complete the activities we do in science class? **9**. Do you feel like you are learning in science class? **10**. Do you feel challenged in chemistry class?	**7**. 6 students were confident on this response with 3 students responding "usually". **8**. All of the students responded confidently. **9**. 6 students said "yes", 2 students said "most of the time", and 1 student said "not really". **10**. 5 responded "yes", 2 said "a little bit", and 2 others said "no".

Most students responded in a positive manner to the question regarding their attitude towards chemistry class. Lab activities and demos seemed to be the most likeable classroom activities to a majority of the students interviewed. Not too surprisingly, the activities that students liked the least were writing down notes and taking tests. Most of the students did respond positively to the questions which dealt with their attitude towards learning. Overall, I was very pleased with the student responses. Taking into account the student responses to both the survey and interview questions, in addition to the improved quality of the lab reports, I can truthfully say that the implementation of differentiated instruction has vastly improved the student attitudes and confidence levels in the chemistry classroom. Having students of varying degrees of classroom achievement (high, middle, and low) work in the same groups, or stations if you will, have created a learning environment that appears to have helped all involved. The lower achieving students were helped by both the middle and top achievers, and they in turn, were helped by having to explain and teach the various concepts to the weaker students. As one of my higher achieving students noted in the interview, “it seems to me that whenever I have to explain something to a classmate, I will usually clearly remember whatever it was that I explained.” Or as one of my struggling girls stated, “no offense Mr. Rojo, but I sometimes understand things better when it’s explained by another student that when you explain it.” No offense was taken!

As I already noted, due to the poor parental participation with their survey, I was only really able to use the Likert student survey and the individual interviews to help answer the sub question, “What are the effects of differentiated instruction on the level of student confidence and self-assurance in the chemistry classroom?” In looking at the student survey, students had a slightly more positive feeling towards school in general than to the chemistry class.

Nevertheless, I was still quite content with the student relative positive feelings of confidence towards the chemistry class. Students seem to value the activities we do in class, with the majority of the students valuing the lab activities the most.

As previously stated, there were substantial quotes from the student surveys that would seem to corroborate the student preference to the laboratory activities. The incorporation of differentiated instruction to the lab groups seemed to be a major factor of this positive outlook by the students. As one of my struggling students told me, "I think that this new lab group set-up was a big help to me. It really made the labs more enjoyable than ever." Or as another student noted, "I found the new station-group arrangement that Mr. Rojo put into place helped me in making some new connections with people in the class that I probably would have never made otherwise."

Student responses from the individual interviews support the finding from the Likert student survey. The students reported liking school and being enthusiastic about the chemistry class. Students had the confidence they were being successful in chemistry class and felt comfortable with the work load and their level of preparation before tests. As one student said, "I feel like I have a real good chance of getting an A or B in this class … I never really felt that way before in my other science classes." As with the survey, interviewed students cited lab activities as being the most fun and easiest to learn from. Even though I interviewed three different student ability groups, responses were even amongst all of the mixed ability groups.

What this data from the Likert student survey and the individual student interviews I developed a very comfortable feeling with regards to the student confidence level in my chemistry class. The survey and interviews tell me that the students feel comfortable about being in my chemistry class and that they now seem to have a very positive outlook about science in

general. No new research questions stemmed from either of these data sources. However, I do believe that as I develop my differentiated instruction delivery methods in future situations, I would like to incorporate even more lab activities (which cover the necessary standards and time permitting, of course) in order to build even more of a positive attitude within the classroom. This is especially important, in my honest opinion, being that lab activities seem to be one of the students' favorite things to do in my chemistry class.

Sub- question # 3

The final question in my action research project was "what effect will the implementation of differentiated instruction in the classroom have on the classroom teacher?" I believe that this is a very important question to address since the overall teacher psyche and attitude towards his or her work will greatly affect the classroom atmosphere and environment. When some new instructional methodology is developed by the powers that be, one would hope that its effects on both students and teachers will be considered. The three instruments used to measure this effect were the teacher journal kept by myself during this project, the teacher survey, and the teacher evaluation.

I will start a bit backwards here and begin with the last item on the list: the teacher evaluation. The reason I feel it might be best suited to begin with this instrument is due to the fact that this has already been somewhat discussed in the methodology section – at least the evaluation method has been discussed. I have already stated that I did receive a "highly effective" rating for 50% of my overall grade. As my direct supervisor, Mrs. Kolassa, told me during the evaluation discussion period, "Your use of differentiated instruction in the classroom is very refreshing to see. We may even have you lead a workshop next year on this very topic … it's definitely the direction that we're heading in."

I do believe that DI is going to be a very large component of any future educational direction that, not only my school, but the entire school district is moving towards. My only concern with how the school, or school district rather, might employ the use of differentiated instruction is in the realistic – or unrealistic – expectations that they will have with the teacher application of DI. I suppose that the conclusion to this report will probably be a better place to discuss this in a bit more detail. Overall, however, I can say with complete confidence that using differentiated instruction in my classroom last semester has definitely helped in improving my overall teacher evaluation. Does that mean that I now believe I am an overall better teacher as a result of this endeavor? Well, once again, I will leave this for the upcoming conclusion; nevertheless, even without a detailed explanation at this point, I can at least answer that question with a resounding and emphatic yes!

The teacher survey (see Appendix C) was given out to seventeen science teachers both in my school and throughout the school district. Of the seventeen teachers that I approached with the survey, fifteen of them agreed to fill it out. This survey was given out during the month of November last semester – I wanted this done before the semester exams and the holiday season drew near, for I feared that at that point in the semester, the teacher response ratio to the survey would decline dramatically.

Most of the answers given in the survey did not really have any eye opening results (with one noticeable exception!) with regards to how most of the teachers answered the questions. I believe this to be the case for the simple reason that I am usually listening to many of these teacher discussion in the school lounge and department meetings, and have already heard many of these answers before. I have summarized the results to the survey questions in the following table:

Table # 6
Teacher Responses to Survey Questions (N = 15)

Questions	Strongly Agree	Agree	Disagree	Strongly Disagree
1-2 Does teacher like the school/class environment?	6	6	2	1
3-6 Do students have good grades and attitudes in class?	4	5	4	2
7-8 Are classroom activities engaging and do they help the students learn?	4	5	3	3
9-12 Has DI had a positive effect on me and my students?	5	6	3	1
13-14 Do I have enough time to plan my lessons and teach them?	5	7	2	1
15 Do I have enough time to implement DI in my classroom and keep up with the pacing guide?	0	0	0	15

* *See appendix E for the survey questions.*

Question # 15 revealed some striking results which warrant some individual attention, rather than its being addressed as part of a group of questions. As one can see, this particular question on the time factor , as it relates the teacher use of DI to keeping up with the district pacing guide, had the only real unexpected result – well, at least unexpected to me. I was already

aware that many of the teachers in my school and in the district, and to be perfectly forthright, throughout the country, are most likely short on time when it comes to applying any new sort of methodology to their classroom. New teaching methods require time to learn, and master. Many teachers just never seem to have the time to get everything done; hence, the half filled parking lots at five o'clock in the evening – two hours after their "work-day" is supposedly over. However, I was not expecting to get 100% of the teachers to say that they "strongly disagreed" with having enough time to utilize differentiated instruction in their classroom and be able to keep up with the district pacing guide at the same time. Also, it appears that a majority of the teachers on this survey (73%) believe that DI will enhance a students' academic prowess. This belief does not seem to correlate too well with the static test results from my own two classes after the implementation of DI. Again, one must remember that the test results within my classroom may have improved far more substantially had DI been in use for a longer period of time throughout the year.

The final piece of collected data used to answer sub-question #3 was my own reflective teacher's journal. Timing considerations were raised by colleagues, and based on review of the journal entries from the second week of the action research project, it appears that the time issue merits further consideration. It seems that a majority of my entries were directly related to the lack of time and the stress over the end of course exam that my students will be taking in May. The district itself makes up this exam and, unfortunately, I do not really have a very clear notion of what topics from chemistry might be emphasized on the exam. I, therefore, have to cover arduous amounts of material throughout the school year. I am aware that teachers in other subject matters are going through the same struggle as I am.

On a more positive note, I did notice a lot of entries which were related to sense of delight I felt as my students started to feel more confident about their performance and, more importantly, their understanding of the material being taught. Here's an entry from November 14th, "Wow, that was a really good class I had today in 6th period … looks like I'm finally getting through to them!" There were numerous other positive entries such as that, which tells me that overall, the use of differentiated instruction in my class has certainly helped me grow as a teacher. This belief was also supported by the teacher responses to question # 13 "Using differentiated instruction techniques in my class have helped me grow as a teacher", where 13 out of 15 teachers either agreed or strongly agreed with that statement. By and large, the effect of using differentiated instruction in the science classroom had an overall positive result in my classroom. True, the time factor seems to be a major challenge; nevertheless, with very careful planning, and implementation over a longer period of time, there appears to be a worthwhile foundation for its use.

CONCLUSION

After the end of the second marking period at the end of December 2012, I spent the next three months organizing and analyzing all of the data that was collected during that time period. In order to answer my main focus question, "what are the effects of differentiated instruction on student performance in a chemistry classroom?" three additional sub-questions were asked and, I believed, answered by this action research project. In this concluding portion of the paper, I will summarize the three sub-questions which address the effect of differentiated instruction on the student achievement, student confidence level, and the differentiated instruction teacher itself. The sub-questions themselves were as follows: how does DI impact student achievement on chemistry assessments?; what are the effects of DI on the level of student confidence and self-

assurance in a chemistry classroom?; what effect will the implementation of differentiated instruction have on the classroom teacher?

The data pertaining to the effect of DI on the academic achievement of the science student was measured by using student test scores, homework completion, and the quality of lab reports. The results of the student test scores when differentiated instruction was implemented versus when it was not, showed no significant improvement (a 68% class average with DI versus 67% without it). This was a bit surprising when one considers the results for the other two instruments used to measure this particular sub-question. Both the percentage of homework completion as well as the quality of the written lab reports did show considerable improvement when DI was applied in the classroom. The tune-up stations appear to have played a big role in the group work component of the class which did include solving and completing homework questions (89% completed the work using DI , whereas 78% completed the assignments without DI) and working on the lab reports (86% average report grade with DI versus 74% without it). Qualitative data collected from both the student surveys and interviews supports the overall positive effect that differentiated instruction (tune-up stations) had on, at least, the student's homework and lab grades.

The second sub-question dealt with the effect of differentiated level of student confidence and assurance in the chemistry classroom. This is the portion of the study in which DI seems to have made its most noticeable impact. The two main instruments used for this component of the project were student surveys and student interviews. Unfortunately, the third instrument, a parental survey, did not have enough completed surveys to really count it as a viable source of information. The overall results of both the student survey and interview indicated that the majority of the 48 students felt an increased level of confidence and assurance with regards to

their overall experience in the chemistry classroom. In order to have more substantial evidence on the effect of differentiated instruction with regard to this second question, I had both classes fill out a brief "ticket out the door" near the end of the of the 4th marking period. I did not add this information in the previous data analysis section of this paper due to the fact that the information was collected after the research period had "officially" ended; nevertheless, I felt that it would be wise to have some sort of "before and after" qualitative data. The two questions on the "ticket out the door" (aka "exit card") were as follows:

Question # 1: "How confident do you feel about successfully completing your H.W assignments on time since we stopped using the tune-up stations in class? (Please circle one)

very confident somewhat confident not very confident

Question # 2: How confident do you feel about successfully completing your lab reports on time since we stopped using the tune-up stations in class? (Please circle one)

very confident somewhat confident not very confident

The results were very supportive of the positive value that differentiated instruction had on my students. Out of a total of forty three student (five were absent on the day the ticket was filled out), 29 out of 43 students (67%) of the students stated that they felt "not very confident". A total of eight students out of the forty three stated that they felt "somewhat confident" (19%), and finally, only six out of the forty three students (14%) claimed that they felt "very confident" about their success without the use of the tune-up stations. This data shows in definitive terms that the use of differentiated instruction in the science classroom had a very positive effect on the confidence level and assurance of the students.

The final component of the project dealt with the effect of differentiated instruction on the actual classroom teacher. This effect was measured by using a teacher survey, teacher reflective journal and a teacher evaluation by a supervisor. The majority of the teachers (73%) involved in the survey did believe that the use of DI in their classroom made them better teachers and also helped the students' confidence level. However, one must also be aware that the unanimous majority of the teachers (100%) surveyed also felt that there would be a major conflict between the implementation of differentiated instruction and the ability to keep up with the mandated pacing guide that the school district has designed. The teacher evaluation did confirm that DI was a very helpful instrument in improving the classroom portion of the teacher grade. My own reflective journal showed that I also found a problem with the time frame for the average classroom teacher. Apparently, it would be very difficult to both apply differentiated instruction at regular time intervals and also maintain the pace of the district guide. In fact, I truly believe that if I had used DI throughout the entire school year, I would have probably fallen about six chapters behind for this school year. That would mean that my students would have scored quite low on the end of course exam. That would probably have given me a much lower rating in the final teacher evaluation. Thus, a major challenge would be in finding a way to cover all of the required material and still find a way to employ differentiated instruction.

It appears that the use of differentiated instruction does have a very important place in the classroom to, at the very least, improve the level of student confidence and assurance. It must also be noted, that the amount of time spent on the use of DI must be very carefully monitored so as to not fall behind on the coverage of the content area material. Perhaps a slight change in the school day classroom time, or a less demanding pacing guide (which now requires the teacher to

complete almost the entire textbook), or less periods per day would allow for a more consistent use of this otherwise helpful teaching device.

VALUE

So where do we go from here with the use of differentiated instruction in the science classroom? Its significance cannot be denied, yet, considerable changes in the approach of its implementation would have to be made in order to have enough time throughout the school year to finish all of the required material that will be assessed in the end of course exam. Based on the data that was collected and analyzed during the research period, I would recommend the following changes for the application of differentiated instruction in my classroom during the 2013-14 school year:

- ✓ A longer implementation period *throughout the year* would be needed for any DI instruments used in the classroom to allow for a more prevailing positive effect on the assessment component of the first sub-question.
- ✓ The DI instruments themselves would have to be engaged for a shorter period of time *during each class period* to allow for the coverage of the required course material.
- ✓ Pre and post surveys and interviews should be used in order to obtain a richer connection on the effect of DI to the student confidence level in the science classroom (sub-question # 2).

By employing the use of the tune-up stations, which as it turned out, was the most effective DI instrument used in my classroom this past year. The data on academic achievement (other than the test scores) showed itself to be quite encouraging with the use of DI: 89% of the students completed their homework assignments with the use of DI versus 78% without it; the average lab report score jumped from a 74% average without DI to an impressive 86% with

differentiated instruction. I believe that by differentiated instruction (especially the tune-up stations) throughout the entire school year, the test scores might also improve quite dramatically. The student confidence level also suffered during the second half of the school year when DI was no longer being used in the class. This was very apparent to me by the use of the ticket-out-the door which I had the students fill out towards the end of the school year. Over two thirds (67%) of the students stated that they were "not very confident" about their success in my class after the DI treatments were removed.

The major challenge in my classroom while using DI during this past school year, was the ability to cover all of the required course material at the pace mandated by the school district. The teacher survey showed a very surprising number of the teachers (100%) felt that they would not have enough time to keep up with the pacing guide while using differentiated instruction practices in their classroom. Two possible solutions for this dilemma would be to spend a bit less time during each of the class periods on the use of DI. Perhaps even a five minute reduction in DI usage per period, would allow for the teacher to complete the required course content. Another possible avenue to consider, although independent of the DI itself, would be to find a more concise way to deliver the content material to the students. This is something that we will have to discuss as a science department during the pre-school week before the official start of the new school year.

Finally, it is my firm belief that the use of both *pre* and *post* student surveys and interviews would further support the positive effect of DI implementation on the student confidence and self-assurance level. Whereas the ticket-out-the –door that I used towards the end of the year did show that a majority of the students (67%) did not feel as confident in the class once the differentiation was removed, it would be far better, in my opinion, to have the same

survey and interview questions done before and after the DI is deployed. Not applying this pre and post method during this was a foolish oversight on my part, and I intend to correct this oversight during the upcoming school year. A definite modification to the use of DI in my classroom for the upcoming school year will involve the use of student surveys and interviews both *before* and *after* the instruments have been applied to the class.

As I look back on this past school year and the results of my action research project involving the use of differentiated instruction in the science classroom, I am left with a mixed feeling of great satisfaction and unfulfilled potential. I am very pleased and satisfied with the overall effect that the application of differentiated instruction has had on my student's self-assurance and confidence level. I am also pleased in that, along with myself, many of my colleagues (73%) throughout the school district also believed that the use of DI in their classroom made them better teachers. The level of homework completion (89% completed the homework using DI , whereas only 78% completed the assignments without its use) and the overall quality of the student lab reports (an 86% average report grade was recorded with the use of DI versus a 74% average without it) was another aspect of this project that I am very pleased about. I am not, however, completely satisfied with the overall effect that DI had on the assessment scores on the unit tests that my students took while doing the tune-up stations. I believe that this can be remedied by simply applying the differentiation throughout the entire school year, as opposed to just one marking period. As my advisor and mentor Dr. Walt Woolbaugh stated in his review of this paper, a "one shot deal, no matter how well done, is only one shot**.**" I completely agree with that assessment and hope to improve on those results during next year's use of differentiated instruction in the science classroom.

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APPENDICES

APPENDIX A

STUDENT SURVEY

Student Survey Questions Name_____

Please complete the survey by reading each statement and circling how much you agree with the statement.

1. I like school.
    i. Strongly Disagree Disagree Agree Strongly Agree

2. I get good grades in school.
    i. Strongly Disagree Disagree Agree Strongly Agree

3. I like chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

4. I get good grades in chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

5. I always try my best in school.
    i. Strongly Disagree Disagree Agree Strongly Agree

6. I always try my best in chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

7. I would probably do well in chemistry when I take it in college.
    i. Strongly Disagree Disagree Agree Strongly Agree

8. The activities we do in chemistry class help me learn.
    i. Strongly Disagree Disagree Agree Strongly Agree

9. The activities we do are fun.
    i. Strongly Disagree Disagree Agree Strongly Agree

10. Chemistry is boring.
    i. Strongly Disagree Disagree Agree Strongly Agree

11. I enjoy the review activities we do in chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

12. I enjoy the lab part of science class.
    i. Strongly Disagree Disagree Agree Strongly Agree

13. I enjoy the discussion part of chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

14. I do not like any part of chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

15. I feel like I know what is going on in chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

16. I am confused in chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

17. I learn in chemistry class.
    i. Strongly Disagree Disagree Agree Strongly Agree

APPENDIX B

IRB EXEMPTION FORM

MONTANA STATE UNIVERSITY
Request for Designation of Research as Exempt
MSSE Research Projects Only
(10/14/11)

****
THIS AREA IS FOR INSTITUTIONAL REVIEW BOARD USE ONLY. DO NOT WRITE IN THIS AREA.

Confirmation Date:
Application Number:

****

DATE of SUBMISSION:

Address each section – do not leave any section blank.

I. INVESTIGATOR:

Name: **Pablo Rojo**
Home or School Mailing Address: 14075 Ken Austin Parkway, Brooksville, Florida
Telephone Number: (352) 797-7020
E-Mail Address: rojo_p@hcsb.k12.fl.us
DATE TRAINING COMPLETED: **3/6/2011** [Required training: CITI training; see website for link]

Investigator Signature **Pablo Rojo**

Name of Project Advisor: Dr. Walter Woolbaugh
E-Mail Address of Project Advisor: walter.woolbaugh@ecat.montana.edu

II. TITLE OF RESEARCH PROJECT: Studying the Effects of Differentiated Instruction in the Science Classroom

III. BRIEF DESCRIPTION OF RESEARCH METHODS (If using a survey/questionnaire, provide a copy).
Student survey and student questionnaire will be used to collect data for this project.

IV. RISKS AND INCONVENIENCES TO SUBJECTS **(do not answer 'None')**:

V. SUBJECTS:

A. Expected numbers of subjects: **47**

B. Will research involve minors (age <18 years)? **Yes** No
(If 'Yes', please specify and justify.)

C. Will research involve prisoners? Yes **No**

D. D. Will research involve any specific ethnic, racial, religious, etc. groups of people?
(If 'Yes', please specify and justify.) Yes **No**

VI. FOR RESEARCH INVOLVING SURVEYS OR QUESTIONNAIRES:
(Be sure to indicate on each instrument, survey or questionnaire that participation is voluntary.)

A. Is information being collected about:

Sexual behavior?	Yes	**No**
Criminal behavior?	Yes	**No**
Alcohol or substance abuse?	Yes	**No**
Matters affecting employment?	Yes	**No**
Matters relating to civil litigation?	Yes	**No**

B. B. Will the information obtained be completely anonymous, with no identifying information linked to the responding subjects? Yes **No**

B. C. If identifying information will be linked to the responding subjects, how will the subjects be identified? (Please circle or bold your answers)

By name	Yes	**No**
By code	**Yes**	No
By other identifying information	Yes	**No**

B. D. Does this survey utilize a standardized and/or validated survey tool/questionnaire**? (If yes, see IRB website for required wording on surveys and questionnaires.**) Yes **No**

VII. FOR RESEARCH BEING CONDUCTED IN A CLASSROOM SETTING INVOLVING NORMAL EDUCATIONAL PRACTICES:

A. A. This research project must be approved by your Principal or School Administrator, unless there are circumstances or policies that do not make this possible. **Provide a copy of the principal's signed approval.** If such approval is not possible, please explain.

A. **B. Participation of your students in research must be voluntary** and can never affect their rights. Please make this issue clear on all of your research surveys (use introductory text, see below) and/or interviews (use introductory verbal statement,

see below). The following wording or something similar can be used for the introductory text or statement: **Participation in this research is voluntary and participation or non-participation will not affect a student's grades or class standing in any way.**

A. C. Extra credit should not be used to encourage participation. If you absolutely need to use extra credit, then an alternative activity involving the same amount of time and effort must be provided for those who choose not to participate. This must be clearly described in your IRB application.

D. E. Depending on your school policies, **consent forms may or may not be required for your research.** Please indicate whether you will be using consent forms or not. If you are not using consent forms, please justify (e.g., school policy, etc.). **If you do use consent forms, you must include signature lines for parental consent AND student assent.** (Please use accepted format from our website and provide a stand-alone copy. Do not include form here.)

APPENDIX C

TEACHER SURVEY

Teacher Survey Questions Name_____

Please complete the survey by reading each statement and circling how much you agree with the statement.

1. I like working at my school.

   Strongly Disagree Disagree Agree Strongly Agree

2. I like teaching my science class.

   Strongly Disagree Disagree Agree Strongly Agree

3. Most of my students get good grades in school.

   Strongly Disagree Disagree Agree Strongly Agree

4. Most of my students get good grades in my science class.

   Strongly Disagree Disagree Agree Strongly Agree

5. My students are not often engaged in my class.

   Strongly Disagree Disagree Agree Strongly Agree

6. My students don't really care about their grades.

   Strongly Disagree Disagree Agree Strongly Agree

7. The activities we do in chemistry class help the students learn.

   Strongly Disagree Disagree Agree Strongly Agree

8. The activities we do in class are fun and engaging.

   Strongly Disagree Disagree Agree Strongly Agree

9. Using differentiated instruction techniques in my class have helped the students academically.

   Strongly Disagree Disagree Agree Strongly Agree

10. Using differentiated instruction techniques in my class have helped to build the students confidence.

    Strongly Disagree Disagree Agree Strongly Agree

11. Using differentiated instruction techniques in my class have helped me grow as a teacher.

Strongly Disagree Disagree Agree Strongly Agree

12. Using differentiated instruction techniques in my class has enhanced my evaluation grade .

Strongly Disagree Disagree Agree Strongly Agree

13. I have enough planning time to get my lessons well planned.

Strongly Disagree Disagree Agree Strongly Agree

14. I have enough time in class to get the lesson finished

Strongly Disagree Disagree Agree Strongly Agree

15. I have enough time to apply differentiated instruction in my classes and to keep up with the district pacing guide.

Strongly Disagree Disagree Agree Strongly Agree

APPENDIX D

GROUP WORK ATTITUDE SURVEY

1. Rank the following learning settings on a scale of 1-4, with 1 being you least favorite setting to learn in and 4 being your most favorite setting:

___ Learning independently
___ Learning directly from your teachers
___ Learning in pairs
___ Learning in small groups

Explain why you ranked the learning settings in the above order. What is it about each learning setting that works well or doesn't work well for you?

2. Below is a list of jobs or roles that you could have as part of a group. First read through the list of roles and descriptions. Then rank the jobs from 1-10, with 1 being your least favorite and 10 being your most favorite job to do *(Lin, 2006, p.36)*.

Rank	Group Role	Task in Group
___	Leader/manager/organizer	Manages the group and ensures that members fulfill their roles in a timely manner.
___	Recorder	Records the groups' answers and discussion outcomes.
___	Materials manager	Collects materials for the group and performs technical information analysis.
___	Skeptic/questioner	Ensures that all possibilities have been explored by posing questions such as "What's another idea?" or "How can we look at this problem in another way?"
___	Reflector	Observes and notes the group dynamics for better future group functioning.
___	Time keeper	Keeps the group on-task and within the time limits for the activity.
___	Encourager/coach	Ensures that all members are participating.
___	Reader	Reads the instruction or any information orally to the group.

___	Reporter/spokesperson	Reports the group's conclusions to the whole class.
___	Checker	Checks group members to ensure that each member can explicitly explain how the conclusion/solutions were derived.

Explain why you picked your top two favorites (9&10):

Explain why you picked your least two favorites (1&2):

3. When you're working in a group what things make you want to participate more? What things make you want to participate less? What could your teachers do to help you participate more?

4. Is there anything else you'd like to share related to group work or about what helps you learn?

APPENDIX E

MULTIPLE INTELLIGENCE SELF-ASESSMENT*

Points:
1 = very low
2 = below average
3 = average
4 = above average
5 = very high

Naturalistic intelligence Total: _____

_____ I like to spend as much time as possible outdoors.
_____ I am curious about what happens to the natural world.
_____ I like to be around plants and trees.
_____ I am very concerned about environmental issues.
_____ I am interested in learning about animals.
_____ I enjoy watching the Discovery Channel.

Spatial intelligence Total: _____

_____ It is natural for me to "see pictures in my head."
_____ I hardly ever forget the faces of people I meet.
_____ I enjoy doing jigsaw puzzles.
_____ I pay close attention to space and color in artwork.
_____ I find places without detailed directions.
_____ I am very interested in at least one of the visual arts (drawing, painting, photography, etc.)

Logical-mathematical intelligence Total: _____

_____ I enjoy playing strategy games like bridge, Risk, and chess.
_____ I solve simple math problems in my head.
_____ I like math courses better than literature courses.
_____ I tackle projects in a step-by-step manner.
_____ I would like to work in a scientific or technical field.
_____ I try to find logical explanations for what occurs.

Bodily-kinesthetic intelligence Total: _____

_____ I like "hands-on" activities (working with your hands and using various materials).
_____ I exercise or play one sport on a regular basis.
_____ My best ideas come when I am moving around (walking, running, etc.)
_____ I am well coordinated.
_____ I get very restless if I have to sit in one place more than a half hour.

Linguistic intelligence Total: _____

_____ I love to read.
_____ When I talk to people, I refer to things I have read.

_____ I enjoy playing word games such as Scrabble.
_____ I get compliments on the way I write.
_____ Listening to a lecture, I try to write everything down.
_____ I like literature courses better than math courses.

Musical intelligence Total: _____

_____ I can carry a tune (correctly sing the notes of a song).
_____ I sing or I play at least one musical instrument well.
_____ I enjoy listening to music.
_____ I frequently hum to myself.
_____ I am aware when something is off-key.
_____ I can recognize important works of major composers (song-writers).

Interpersonal intelligence Total: _____

_____ I am complimented for having "a way with people."
_____ People like to talk over their problems with me.
_____ When working with a group, I am sensitive to who is and who is not participating.
_____ I like sharing or explaining information to other people.
_____ I learn more from live interaction with people than from reading on my own.
_____ I am frequently asked to be a group chairman or leader.

Intrapersonal intelligence Total: _____

_____ I love time to be by myself with my own thoughts.
_____ I can usually figure out why I behave in a certain way.
_____ I like stories that explain a character's psychology.
_____ I find it easy to write about myself.
_____ I enjoy reading and learning things that help me improve myself as a person.
_____ I do not mind being by myself.

Give yourself 5 extra points in any category in which you feel highly talented.

List your top one or two intelligences here:
_____
_____
**Based on Colannino, 2007, p.48*

APPENDIX F

STUDENT INTERVIEW QUESTIONS

1. Do you like school?

   Probe - What about school do you like or not like?

2. Do you find chemistry in general interesting?

   Probe - What do you find interesting about chemistry?

   Probe - Why do you not find chemistry interesting?

3. Do you like chemistry class?

   Probe – Why do you say that?

4. If you could choose 2 words to describe chemistry class what would they be?

5. What are some activities we do in class that you like?

   Probe – Why did you like this activity?

   Probe – Did this activity also help you learn? How did this activity help you learn?

6. What are some activities that we do in chemistry class you are the least comfortable with or do you like the least?

   Probe – What about this activity do you not like?

7. Do you feel like you know what is going on in chemistry class?

   Probe – What are some things we do in class that help you in knowing what is going on?

   Probe – Can you give me an example of when you knew what was or was not going on?

8. Do you feel you are able to successfully complete the activities we do in chemistry class?

   Probe – Why do you say you that?

   Probe – How do you know if you are successful or not? Is this way okay for you?

9. Do you feel like you are learning in chemistry class?

   Probe - What activities do we do that help you learn?

   Probe - What activities are the hardest for you?

10. Do you feel challenged in chemistry class?

11. Is there anything else you would like me to know?

APPENDIX G

PARENTAL SURVEY

1. Does your child like being in school?
2. Does your child find chemistry in general interesting?
3. Does your child like chemistry class?
4. If you could choose 2 words to describe what your child thinks of his/her chemistry class, what would they be?
5. What are some activities that we do in class that your child likes?
6. What are some activities that we do in chemistry class that your child is the least comfortable with?
7. Does your child feel like he/she knows what is going on in chemistry class?
8. Does your child feel like he/she is able to successfully complete the activities we do in chemistry class?
9. Does your child feel like he/she is learning in chemistry class?
10. Does your child feel that he/she is challenged in chemistry class?