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INCREASING STUDENT ACHIEVEMENT AND MOTIVATION BY DIFFERENTIATING INSTRUCTION IN AN INCLUSIVE HIGH SCHOOL CHEMISTRY CLASSROOM

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ABSTRACT

This qualitative study investigated the experiences of incorporating differentiated instruction into an inclusive high school Chemistry classroom. The study was completed in a high school containing approximately 1000 students in the northeastern United States. Seventeen students in grades ten and eleven participated in the study. Some of the students were classified and had Individualized Education Plans. Methods of gathering data included teacher observation, student surveys, informal and formal student interviews, and student work. The students participated in activities that were primarily differentiated according to their learning profile and readiness. Findings suggest that scaffolding is an essential part of classroom instruction for all students. Furthermore, students are likely to have a positive affect when teachers create a positive and caring learning environment. Differentiating instruction according to student profile may also increase academic achievement. Teachers may need to use multiple resources at their disposal, however, to become familiar with all learners in the classroom. Input from students may lead to changes in classroom practice that result in greater student success. Assessing student readiness is clearly crucial when designing meaningful instruction, and a strong collaborative partnership between classroom teacher and special educator is essential to provide support for all learners. Such support may increase student interest in a topic, and, in turn, student engagement.

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RESEARCHER STANCE

When I was roughly the same age as the high school students I teach now, I really didn't know what I wanted to be when I grew up, but because I did well in several accounting classes, I figured I'd become an accountant. I would be working with numbers, which was something I was good at; I would be making lots of money; and I would be working in the city. At the age of 16, I now had a goal for my life, something most of my own students haven't yet developed.

In the fall of 1994, I went to college and began taking general requirement courses and accounting courses at a small college in the eastern United States. I sat in my accounting courses bored out of my mind. I would complete my ledgers at night, and my life was consumed with nothing but debits and credits. For me, it was all very monotonous, and I had to ask myself if this is truly what I wanted to do for the rest of my life.

I came to the decision during my sophomore year of college that I would change my major, but I was not exactly sure how I would do so. I knew I needed to do something that would simulate me, something where I could be actively involved with people. Education had always been important to me, and I had always been a good student and earned good grades. I loved working with people. I come from a big family and have always been around children. Being an elementary school teacher might just be the right career choice for me.

My college advisor explained that a dual major would be required. I am not quite sure why I did not declare mathematics since I had a strong background in it. Instead, I decided to major in special education. I did not have any personal connections with a person with a disability, but I made a truly spontaneous decision, which would change my life forever.

I graduated from college in the spring of 1999 with the goal of becoming an elementary teacher. I happened to send out a resume to a high school for a maternity leave position in special education, was called for an interview, and was offered the teaching job while I was there. It was an exciting and anxiety inducing experience. I figured this was the way I would get into the teaching profession. I did not have plans on staying at the high school level or in special education. Nine years later, I am still a high school special education teacher and quite pleased with my profession.

It has been quite a journey. I began as a special education teacher at a high school in New Jersey, where I made modifications and accommodations in support of students' Individualized Education Plans. The content area teachers whom I worked with collaborated with me on daily lessons and student progress. It was truly a team effort. After two years there, I relocated and started working at a new school. I was hired for the same type of teaching employment that I was doing in North Jersey. It would be an easy transition, or so I thought. I was teamed up with teachers who hadn't really heard of inclusion. The teachers had little to no training on special education and its policies. I was not treated well, and neither were the students with a special education designation. One teacher told me an Individualized Education Plan had no authority in her classroom. The other expected me to be the policeman in the classroom. I found myself having to sneak study guides, which were one accommodation found in the Individualized Education Plans, to students who were supposed to have them. One teacher told me I might as well teach the poster project lesson because, as a special educator, I had to have taken a poster making course in college. More than once I was referred to as the "lovely assistant". I was in a school that did not value my opinions or my professional experiences.

During the school year, professional development opportunities were offered to the staff through a professional academy and professional development days. One of the workshops offered on a professional development day was Tomlinson's Differentiated Instruction. Differentiated instruction "is an approach to teaching that advocates active learning for student differences in the classroom" (Tomlinson, 2003, p. 1). According to Tomlinson (2003),

> Differentiated instruction is responsive instruction. It occurs as teachers become increasingly proficient in understanding their students as individuals, increasingly comfortable with the meaning and structure of the discipline they teach, and increasingly expert at teaching flexibly in

> order to match instruction to student need with the goal of maximizing the potential of each learner in a given area. (p. 2-3)

This suggests that competent teachers adapt instruction based on the needs of the students to ensure success in the classroom. This was important to me because, as a special education teacher, I make curriculum accommodations and modifications to ensure success for special education students in the least restrictive environment. Differentiated instruction can meet the needs of all students in the classroom.

Throughout my tenure, I found that many other students would benefit from the same accommodations and modifications that I made for my special education students. Often times, regular education teachers would not want to incorporate these strategies into the classroom because the modifications carried a special education stigma. I would suggest using graphic organizers, for example, to help students organize the information presented in the unit. Some regular education teachers felt this was a strategy that should be reserved for special education students or students in lower grades. I also suggested using lower level books to explain concepts to the students. The teachers called this babying the students and watering down the material. I had been trying to incorporate strategies that would increase academic achievement for all students and now it had a name: Differentiated Instruction. Would regular education teachers be willing to differentiate instruction for all learners in the classroom?

In order to address the needs of all of the students in the classroom, I have designed this research question: What are the observed and reported experiences of incorporating differentiated instruction into an inclusive Chemistry classroom?

LITERATURE REVIEW

Teaching Strategies in Inclusive Classrooms

According to Special Education Law, students with Individualized Education Plans should be included in schools in the least restrictive environment (Villa et al., 2005). This means many students with Individualized Education Plans are enrolled in regular education courses and receiving in-class support. This is also known as the inclusive classroom. "Inclusion represents the belief or philosophy that students with disabilities should be fully integrated into general education classrooms and schools and that their instruction should be based on their ability, not their disability" (Friend & Bursuck, 2002, p. 4). According to P.L. 94-142, students should be placed in the Least Restrictive Environment. Hence, students with IEP's may be placed in regular education classrooms where collaborative teaching takes place. According to Bauwens & Hourcade (1995), collaborative or co-teaching is instruction given by a regular education teacher and special education teacher in the same classroom. Here special education teachers make accommodations and modifications, which are included in the students' Individualized Education Plans. These accommodations and modifications include but are not limited to the use of a calculator or computer, study guides provided before tests and quizzes, and curriculum modifications. Different teaching strategies can also improve the chance for success for special education students in a regular education classroom (Villa et al., 2005).

Scaffolding Instruction

Scaffolding instruction can increase academic achievement for special education students receiving services in a regular education classroom. Scaffolding instruction is tailoring instruction in a way that leads students from what they can do or already know to what the student needs to do or learn (Graves & Braaten, 1996). A proponent of this type of learning was Lev Vygotsky, who believed instruction should take place within what he called a child's zone of proximal development. "The zone of proximal development is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with capable peers" (Vygotsky, 1978, p. 86). The zone of proximal development is the difference between what a student can learn independently and what can be learned by working with others in the classroom. In order for learning to take place within a Vygotskian framework, it is necessary to scaffold instruction within a student's zone of proximal development.

Larkin (2001) lists guidelines for effective scaffolding. In order to scaffold successfully, it is important for the teacher to be familiar with each student's background knowledge. This will allow the teacher to build the foundation for scaffolding. From this background knowledge, teachers can begin with a task that will bring success to the student, thereby increasing student confidence. Modifications should be made when necessary, which might entail adding mini lessons to the scaffolding process. Lastly, scaffolding should lead students to independence.

Graphic Organizers

Graphic organizers can also be used to assist special education students to comprehend the large amount of content-based information given in the classroom. Special education students can often see links between information when using graphic organizers that they might not otherwise see. Baxendell (2003) believes graphic organizers should be used consistently and that the graphic organizers should be coherent to the students. Teachers should model how to use the graphic organizer. Graphic organizers can be developed and used throughout the year without changing the look of the organizer. If it is possible, the same organizers should be used in other classes as well. According to Baxendell (2003), consistency is important when developing and using graphic organizers. The graphic organizers should focus on what the students should know and not include extraneous information. They should be labeled and cover a small amount of material. Graphic organizers can be incorporated in introductions to lessons, for reviews, as homework, or in cooperative learning activities. If the students are visual learners, they should be encouraged to draw pictures to link information found in the graphic organizer.

Active Learning

Silberman (1996) notes that active learning puts the accountability for learning on the student rather than the teacher, adding, "What I hear, I forget. What I hear and see, I remember a little. What I hear, see, and ask questions about or discuss with someone, I begin to understand. What I hear, see, discuss, and do, I acquire knowledge and skill. What I teach to another, I master" (p. 1). When using active learning strategies, teachers can touch upon multiple learning styles (Silberman, 1996). Students become responsible for their learning by participating in hands on activities or by applying knowledge. Active learning gets students out of their seats and at the forefront of their education. Active learning can occur at many stages in the pedagogical process. Students can engage in team building activities, classroom debates, or reviewing activities. Silver, Strong, & Perini (2001) link active learners to doing, looking, and learning. Doing refers to performing tasks mentally. Looking is being aware of one's thinking. Learning makes connections between what a person knows and the knowledge that has been acquired. When students are actively involved in their learning, the knowledge is stored in their long-term memory.

Authentic Assessment

According to Taylor and Nolen (2005), authentic work is "defined as work that has relevance in the world beyond school (p. 71)". Students will notice the significance of activities that relate to their world. Students should be taught sciences by applying it to their own experiences. It is only then that they will be able to make the link between learning and life. Using real life applications in the classroom can make instruction meaningful and everlasting. “If students are to leave school understanding their role as literate participants in a democratic society, they must have the experiences that empower them to participate in events that affect their lives while they are still in school” (Taylor & Nolen, 2005, p. 76).

Authentic assessments are different from traditional assessment because they require students to tap into higher critical thinking skills (King, Schroeder, & Chawszczewski, 2001). Authentic assessments should link students to real world skills and should be meaningful. The Research Institute on Secondary Education Reform studied the effects of authentic assessments in inclusive secondary schools for five years. Teachers and students from three high schools participated in the study. Teachers evaluated each other’s work for authenticity and the work of students based on an established rubric. Students with disabilities scored higher on assessments with high authenticity than did students with disabilities on assessments with lower authenticity. Over half of students with disabilities scored the same or higher than students without disabilities on tasks when assessments were authentic. Some students with disabilities were given accommodations, which may have changed the level of authenticity. Overall, teachers who created more authentic tasks received more authentic work in return (King, Schroeder, & Chawszczewski, 2001).

Differentiated Instruction

Responsive instruction or differentiated instruction is a prime way to meet the needs of all learners in the classroom. Teachers must look at four traits before differentiation can take place: readiness, learning profile, interest, and affect. After background knowledge is obtained, differentiation can occur in the content, process, product, or learning environment (Tomlinson, 2003; Tomlinson & McTighe, 2006).

Readiness

Readiness refers to how much a student knows about a topic (Tomlinson, 2003; Tomlinson & McTighe, 2006). Although the students may be in the same grade level, they will exhibit varying degrees of readiness in a single classroom. Some students may be proficient in a topic and may not need instruction for that topic. Other students may have some background knowledge on the topic. Some students may not have any background knowledge about a topic at all. Giving students pre-tests can assess readiness. Some instructional strategies, which address readiness are tiering, varied homework, highlighted texts, and materials at varied levels (Tomlinson, 2003).

Tiered assignments can be used as a modification of the content, based on readiness (Tomlinson, 2003). Tiered assignments are designed to have specific goal for all students. The lessons are prepared with various levels of difficulty to meet the needs of all learners according to their background knowledge of the topic and readiness. Instruction can be scaffolded or different versions of a lesson with different levels of difficulty can be created to challenge all of the students. The students may go down different roads but they will meet in the end to achieve the same goal.

Researchers at Indianapolis Public Schools and Ball State University in Indiana conducted a study at the Burris Laboratory School, an inclusion school, which uses a resource consultation model to meet the needs of its students (Pierce & Adams, 2004). The research on how teachers can reach all students was done with a first grade class by tiering a mathematics lesson on fractions. The steps developed from this study have implications for all levels of instruction. The researchers developed a lesson following several steps to properly tier assignments. The teachers chose the grade, level, subject, and objectives for the lesson. An essential question was created from the objective that was meaningful to the students. The teachers analyzed the students' readiness, which set the foundation for the tiered assignment. Tiering took place in the content, process, or product, and teachers created several fraction lessons as a result of the tiering. Lastly, the teachers developed the assessment for the lesson. The researchers found that tiering lesson can eliminate frustration for many students and increase academic success (Pierce & Adams, 2004).

Students can take part in differentiating instruction by assessing their own readiness. Students can choose or create homework assignments, which focuses on skills that should be improved. Teachers can assign homework to students on an individual basis.

Highlighted texts are useful for students whom have a difficult time reading and comprehending the text. Textbooks may be written at a readability level which is higher than that of the students. Highlighted texts will assist the student in organization and comprehending key points in chapters.

Again, students come to the classroom with different academic abilities. Finding materials that are appropriate for the students is challenging, yet beneficial to learning. Students with varied readability levels should have access to texts and supplementary materials with varied readability levels.

Learning Profile

"Learning profile refers to how a student learns best" (Tomlinson, 2003; Tomlinson & McTighe, 2006, p. 3). Learning profiles vary from student to student because of culture, gender, style of learning, or multiple intelligence. Each student brings different background knowledge to the classroom (Keefe & Jenkins, 2002). Some students learn best if a lesson is presented visually (Tomlinson, 2003; Tomlinson & McTighe, 2006). Other students may need to use their hands to learn concepts. One teacher's metaphor as described in

Connelly and Clandinin's *Teacher as Curriculum Planners: Narrative of Experience* compares the classroom to a climbing party.

> The climbing party, like the class, is made up of people that are as different as mountains. One may have great physical strength, but lack experience; one may be eager and cooperative, but need to develop his physical conditioning; and another may be quite intelligent, easily able to see the easiest route, but climb slowly because of his stature. The climbing party brings together a combination and variety of strengths and weaknesses; everyone using their strengths to help the others develop and grow in ways unique to themselves. (Connelly and Clandinin, p.73 1988)

Classrooms are filled with students with different strengths. A teacher should become familiar with the students in his class and their preferred learning styles. He should be competent in his subject and have the ability to teach the subject in a variety of ways. Cooperative learning experiences where all students have an active role can be created and activities customized to the students' learning profile. A learning style inventory or multiple intelligence test can assist teachers in finding out how students learn the best (Tomlinson, 2003). Teachers should not gear instruction to one learning factor, but give students the opportunity to work with many different styles. It gives the students a chance to be successful with their preferred learning style and challenges them with others, which lead to development in other learning styles.

Sternberg (1997) conducted a study in the summer of 1993 called the Yale Summer Psychology Program. The participants of the study were high school students, who were selected after taking a test measuring analytical, creative, and practical abilities. Students involved in the study either showed high analytical ability, high creativity, high practical ability, were high in all three abilities, or low in all three abilities. The students attended classes in the morning with students of similar academic abilities. In the afternoon, the students attended classes that focused on one of the other abilities. Some students were placed in classes that emphasized their learning trait, while others were not placed in their strong area. The students were assessed in multiple ways, including multiple choice tests and essays. One result was that the students attending classes that matched their favored trait performed better than other students. Students who were considered smart varied in gender, race, and ethnicity. This study showed the importance a varying instruction according to a student's learning profile. The students in this study were most successful with their favored learning profile, suggesting that teachers work on strengthening other learning profiles.

Interest

When students are interested in a topic, they will be motivated to learn and the students will be on task longer (Tomlinson, 2003; Tomlinson & McTighe, 2006). "Schools do not pay enough attention to students' curiosity and imagination. As a result, students disengage from active participation in the academic life of the classroom because there is little satisfaction from schoolwork" (Vacca & Vacca, 2005, p.298). Teachers can find ways to incorporate students' interests into the instruction. First, a teacher needs to find out the students' interests by giving the students an interest inventory. Students can also pair up with others students and make a Venn diagram showing things they have in common with each other and things that are different from one another (Baxendell, 2003). Webquests, interest centers, and independent studies are instructional strategies that can be used to bring students' interests into a lesson (Tomlinson & McTighe, 2006).

Shernoff et al. (2003), conducted a study on student engagement in a high school that focused on flow theory, which states that students become actively involved in activities that are essentially pleasurable to them. Researchers found that the students found success when they were interested in a topic. Students were also more engaged in a topic when it was a challenge to them. The task could not be overly challenging, though, because this would lead to frustration in the student. If a task was not challenging enough, the students would be less engaged. Students in this study were also more engaged in classes that were more structured.

Affect

Affect pertains to the feelings of the students (Tomlinson, 2003). When students have a positive affect, they tend to perform better and have more success in the classroom. On the other hand, negative affect can lead to frustration for a student and the possibility that the student will shut down. Teachers need to cognizant of the feelings of students and take them into account during instruction.

Differentiated Content

Content is what will be taught in the lesson and can be differentiated in numerous ways (Tomlinson, 2003). Students can be given graphic organizers while taking notes in the class. When modifying content based on readiness, teachers can use a variety of texts with different reading levels. Tiered lessons can be created to make sure students are ready for the big idea.

Another way to differentiate content is to use the jigsaw strategy. Researched by Robert Slavin (1978) at Johns Hopkins, "jigsaw is a technique developed by Elliot Aronson and his associates at the University of Texas, which is designed to increase students' sense of responsibility for their learning by making them an 'expert' (p. 26)." Students work in two types of groups; the learning group and the expert group (Eilks, 2005). The class is divided into learning groups of five or six. The number in the group will be the same number of topics that will be assigned to the students. The students are each assigned a subtopic, which comes from their main topic of study and tasks to complete about the subtopic. The students leave their learning group and collaborate with their experts group. While the students are in the expert groups, they will research the subtopic and complete the tasks. Texts and websites with various levels of readability can be used to differentiate instruction (Tomlinson, 2003). The students can complete tasks that accentuate their learning profile or students can have choices with the tasks. Rubrics with the expectation for the tasks can be given to the students. After the expert groups have completed their tasks, they should reconvene with the learning group (Eilks, 2005). When the students are in the learning group, each expert teaches the group about the subtopic and explains the tasks to the students. Jigsaw activities can differentiate instruction in many different ways. After all of the groups have completed the jigsaw activity, the students may help the teacher develop the assessment based on their findings.

Process

According to Tomlinson (2003), "process refers to how a student makes sense of or comes to understand the information, ideas, and skills that are at the heart of the lesson" (p. 5). Activities which allow students to apply the information which was presented will lead students to grasp the information. Jigsaw activities can also be used to differentiate the process. Laboratory activities permit students to apply scientific concepts. Homework can also be an activity which will differentiate process.

Product

Product is the way in which teachers will evaluate the students' knowledge of the topic over an extended period of time (Tomlinson, 2003). Tests can be used as well as other assessment techniques. Students can create PowerPoint presentations to show their competence in the subject. Teachers can assess students with authentic assessments or with portfolios.

Authentic assessments are a useful strategy that can be used for all students in the classroom (Keefe & Jenkins, 2002; Lawrence-Brown, 2004). Authentic assessments link activities to the real world. This type of activity can become more meaningful to students because the students can relate to the activities (Lawrence-Brown, 2004). Authentic assessments motivate students to learn. This type of assessments can also address goals, which are found in Individualized Education Plans.

Learning Environment

If it is possible, the learning environment should be considered when using differentiated instruction (Tomlinson, 2003). If teachers have their own classroom, they should set it up in a way that supports differentiated instruction activities. The classroom can have learning centers. A variety of texts can be displayed throughout the room. Sometimes this may not be possible because teachers travel from room to room, in which case teachers might use various internet sources. Teachers can also use a cart to travel with the texts. Teachers should have all materials ready for differentiated instruction activities. Another aspect of the learning environment that should be considered is the mood. Students should feel comfortable in the classroom.

Supporting the Teaching of Chemistry

Many times special educations students are receiving support in regular education courses, such as science class. Science courses at the high school level are an essential part of the curriculum and are required at most schools. One of the courses taught at this level is Chemistry, which some students identify as a difficult and sometimes boring course, making it all the more crucial to provide students with learning support (Swanson, 1995). Strategies which support the chemistry classroom may include visualizations, technology, and cooperative learning.

Visualizations

Chemistry concepts such as molecular structure and the geometry of molecules are sometimes abstract and hard for students to understand. Visualizations can increase academic achievement with these types of chemistry concepts (Wu, Krajcik, & Soloway, 2001). Wu, Krajcik, & Soloway (2001) conducted a study with seventy-one students and three teachers in an eleventh grade Chemistry course in a Midwestern high school. The objective of the six-week study was to use the tool, eChem, "a computer-based visualizing tool" and to find out if it assisted students in visualizing chemical representations (p. 1). Data were collected in a variety of ways, including logs, videos, interviews, and tests. Observations showed that students had more on task behaviors. Analysis of videos showed students were highly engaged. From using eChem, students developed the ability to create mental images, which led to academic success. The data collected from pre-test and post-tests showed a significant improvement in chemical representation, chemical concepts, representation and properties and molecular structure.

Technology

According to Swanson (1995), using technology in the Chemistry classroom not only enhances the curriculum but also increases student motivation and attitudes. Swanson, a high school Chemistry teacher from Madison, Wisconsin, used a computer to input grades and find averages for each student. Videotapes and laser discs were utilized during lessons plans on a daily basis. Computers in the classroom were a resource students used to conduct virtual laboratory experiments. A computer program for collecting data from pH meters or thermometers was used for the laboratories. Swanson reports that using these technologies allowed her students to receive feedback from her in a timely manner.

The participants in Swanson's (1995) action research project included 120 chemistry students from varying chemistry classrooms. Swanson logged observations made during lessons in the class and surveyed the students using a Chemistry Attitude Survey and an Incomplete Sentence Inventory. The Chemistry Attitude Survey contained statements that students would rate on a Likert scale. The students completed sentences with their opinions for the

Incomplete Sentence Survey. The observations and surveys results indicated that the students found technology to be beneficial. The students found the immediate feedback to be useful, and they reported being motivated to improve their performances based on the computer-generated results. The technology allowed for more demonstrations and class time to solve problems. According to the Chemistry Attitude Inventory, most students felt class discussions were more interesting when the different technologies were incorporated. Swanson found that incorporating technology into his classroom increased interest in Chemistry.

Cooperative Learning

In many chemistry classrooms, laboratory experiments occur in cooperative learning groups. Bowen (2000) conducted a meta-analysis on the effects cooperative learning on high school and college chemistry achievement. Three studies at the high school level, which included over 400 students, were included in the meta-analysis. The effect sizes of the three studies were .71, .59, and .07, which showed varying degrees of an increase in academic achievement. The three high school studies were analyzed with eleven college level courses. From the meta-analysis, students in classrooms with cooperative learning scored 14 percentile points higher than students in conventionally taught courses, which were in the 50^{th} percentile. Results from this meta-analysis showed cooperative learning can be useful in both high school classrooms and college courses.

Pratt (2003), a Chemistry teacher at Woodstock Academy in Connecticut found cooperative grouping could improve classroom management, social skills, and retention of academic content. The groups can be formed by random selection or according to mixed abilities. After the groups are formed, students can give each other their personal information such as telephone numbers or electronic mail addresses. The students can contact each other for homework, to study, or for support. Pratt found that grouping strategies did not always work right away, and that it often took time to see the benefits of cooperative grouping.

Co-teaching

In order to have a successful inclusive classroom, collaboration between the regular education teacher and the special education teacher should take place (Murawski & Dieker, 2004). With effective professional development and a positive outlook on inclusion and co-teaching, teachers can develop a successful partnership. Evaluation of the team should take place in order to determine its effectiveness (Salend, Gordon, & Lopez-Vona, 2002).

Often school administrators will accept volunteers for co-teaching (Friend, 2007). Other times, teachers are assigned to inclusive classrooms. Either way both special education teachers and regular education teachers come to the classrooms with their own fears. Regular education teachers sometimes feel like they are being judged in their classroom, while special education teachers feel they are not valued. Providing professional development opportunities can eliminate some of those fears (Friend, 2007).

Before co-teaching begins, professional development is necessary (Friend, 2007; Keefe, Moore, & Duff, 2004; Murawski & Dieker, 2004). Teachers should be informed of what co-teaching is and the expectations of the school in regards to co-teaching. Researching information from articles on inclusion and co-taught classrooms before teaching in the inclusive classroom has proven successful. Teachers might research by themselves or in concert with school administrators. Teachers working in the same classroom should get to know each other and their respective educational philosophies. A survey including such things as expectations about homework, responsibilities of each teacher, behavior management, and any other issue that may be of importance to the teachers can be completed by the teachers working together. Roles and responsibilities need to be established before the students enter the classroom (Friend 2007).

In order for co-teaching to be successful, the collaborative partners need to share the same goal (Friend, 2007). Both partners must believe that all students can learn by using the expertise of the regular education teacher and the special education teacher. "Teachers in inclusive schools do not think or talk in terms of 'my kids and your kids' when they refer to students who receive some type of special service" (Friend & Pope, 2005, p. 58). Taking the time to choose specific teaching methods and creating lessons that allow both teachers to be involved will be more likely to lead to a successful collaborative relationship and classroom.

According to Murawski and Dieker (2004), three major components for creating a successful inclusive classroom include planning, instructing, and assessing. Co-teachers need to find time to plan together. If a common preparation period is not available, teachers should find time before or after school. Some schools may allow co-teachers to plan during a professional development day. Electronic mail can be used when teachers do not have a common planning period (Friend & Pope, 2005). Teachers can also save plans on a server so others have access to them.

When instructing students with different abilities, a variety of learning styles and co-teaching models should be used to maximize the learning experience (Murawski and Dieker, 2004). If one teacher is taking roll, the other can collect or check homework. Together the regular and special education teachers must determine the type of co-teaching that will occur in the classroom for each lesson. Friend and Bursuck (2002) suggest using One-Teach-One Support, One-Teach-One Drift, Alternative Teaching, Parallel Teaching, Station Teaching, or Team Teaching.

Assessing students can be a difficult task especially when special education students are now responsible for taking high stakes tests (Murawski and Dieker, 2004). Students should be discussed individually in order to determine modifications to tests or grading. Assessments should vary to show the best in each student. Alternative assessment can be considered.

Weiss and Lloyd (2003) conducted a case study on co-teaching at both the middle and high school levels. Teaching experiences of the special education teachers ranged from three to ten years, while co-teaching experience varied from one year to six years. Planning time between the special educators and their general educator varied. Some teachers received common planning time and others did not receive time to plan. The co-taught classes included science, math, English, and history.

The data collected for this case study included observations, interviews, and journal entries. The results of the data showed that the teachers took on different roles on the classroom. Some teachers, usually at the high school level used the "one teach, one drift" model of co-teaching. One teacher led the discussion and the other gave individualized attention to students throughout the class. Another way special education teachers were being used in a co-taught classroom was by dividing the group in half. Then one teacher would leave the class and go to a different classroom. Each teacher would teach the same basic lesson. This model was often used when behavior was an issue in the class. Some teachers taught the same content, but stayed in the same classroom. The last model observed by the researcher was team teaching. One teacher at the middle school worked using this model, and she happened also to be the teacher with the most experience in co-taught classrooms.

Those who provided support often times did this because they were not comfortable with the content. They also felt the regular education teacher was resistant to working with another teacher. Behavior management issues cause many teams to teach the same content by splitting the class. Team teaching occurred only when there was respect for one another and their teaching styles.

Salend, Gordon, and Lopez-Vona (2002) emphasize the importance of teachers and administrators evaluating the effectiveness of teaching teams. Therefore, rather than assuming that cooperative teaching teams are working effectively, information on educators' experiences and reactions to working as a cooperative team should be periodically collected and examined by a diverse program evaluation team that includes professionals, family, community members, and students.

The study suggests information also be collected from students and their family members. They recommended using a variety of ways to test the success of cooperative team teaching. These methods included surveys and interviews, best practice checklists, conduct teaching observations, journals, and portfolios. Conducting surveys is a fast and easy way of collecting information about cooperative teams. Although surveys are easy to complete, they do not always give enough information. The use of interviews or questionnaire gives an evaluator a more thorough analysis of the team.

Another way to evaluate teams is by completing a best practice checklist (Salend, Gordon, & Lopez-Vona, 2002). These checklists can be done individually or as a team. The checklists give teachers a way to reflect on their work in an inclusion classroom. Although self evaluation is important to the success of team teaching, other times it may be useful to get others to observe the class. Observations should be done by several teachers to give the team an idea of their strengths and weaknesses in the classroom.

Lastly, journals and portfolios can be used to evaluate the successfulness of an in inclusion classroom (Salend, Gordon, & Lopez-Vona, 2002). Teachers can write daily logs on the classroom procedures and routines. Teachers can write down what was successful about the lesson and what needs to be worked on. Portfolios can be kept and would include lesson plans, philosophies, etc.

After collecting various evaluative materials, teams can discuss the results. Teachers can find the successes of cooperative teaming and weaknesses and failures of their team teaching practice. Based on the results, the team can make a plan to improve the teaching partnership (Salend, Gordon, & Lopez-Vona, 2002).

There are numerous benefits from a co-taught classroom. Co-teaching reduces the teacher to student ratio (Friend, 2007). Students lose special education because they receive services with all of the students and are not pulled out of the classroom (Friend, 2007; Friend & Pope, 2005). The knowledge and experiences of each teacher are utilized when creating lesson that meet the needs of all students. Teachers share resources with each other. There may be a decrease in discipline referrals and problems in the classroom (Thousand, 2006). Teachers share the responsibility of paperwork. Hence, student achievement often increases. Teachers have also reported feeling happier in the classroom. With proper professional development and support, successful co-teaching partnerships can occur in classrooms.

Conclusion

In the end, students come to us with different background and academic abilities, so incorporating differentiated instruction into an inclusive Chemistry classroom has the potential to address the needs of all of the learners in the classroom. Gifted students will have the opportunity to extend their learning, while students who need extra assistance will also have the chance to be successful in the classroom.

RESEARCH DESIGN AND METHODOLOGY

Need for the Study

I am a Special Education teacher jointly responsible for the learning of special education students placed within an inclusive Chemistry course in a high school. Although my sole responsibility is to the targeted special education students in the inclusive classroom, I have found that many regular education students also benefit from the accommodations and modifications that are made for the special education students.

Today's classrooms contain students from different socioeconomic strata and cultural backgrounds, students with disabilities, and ESL students. It is important for all educators to teach to all students and not just in the traditional manner of lecturing and taking notes. Incorporating instruction that is differentiated can help students reach the goals of the classroom.

In order to learn more about the observed and reported experiences of incorporating differentiated instruction into an inclusive College Preparatory Chemistry classroom, I conducted a teacher action research study using a variety of differentiated instructional strategies. During the study, I collected various types of data, as outlined below. From these data, I worked to determine the effectiveness of using differentiated instruction in an inclusive College Preparatory classroom.

Setting

I conducted this action research study in an inclusive College Preparatory Chemistry classroom in a fully accredited high school consisting of approximately 1000 students in the northeastern United States. Students from this study came from two different towns. The sending district was a rural town, which contained many upper middle class families. The receiving district was urban with many businesses and contained many lower middle class families. The ratio of males to females was one to one. Seventy percent of the students were Caucasian. Eleven percent were Hispanic. Ten percent were African- American and eight percent were Asian. Fourteen percent of the students in the school were classified as special education students. Approximately eight percent received free lunch and four percent received reduced lunch. The room in which the study took place was equipped with seven student computers, which were supplemented with a mobile laptop station from the media center. The classroom contained six lab tables, which students sat at during laboratories and direct instruction. The room contained lab stools and chairs, which were easily moved for different types of groups.

Participants

Out of twenty-six students, a mixed ability group of 17 students in grades ten and eleven participated in the study. There was an equal number of males and females in the classroom. The median age was approximately fifteen years old.

The study was conducted during a 40 minute Chemistry period that was held five days a week. Four students had an Individualized Education Plan. These students with Individualized Education Plans had a specific learning disability with a discrepancy in mathematics or written expression. Common modifications included the use of a calculator or computer, study guides, and extended time on test and quizzes.

All of the students except one took College Preparatory Biology last year. One student took Introduction to Chemistry. College Preparatory Chemistry was designed to have students study the nature of matter, which will become a basis for the students to build upon for the next science course in the series or for college. Chemistry is the second course offered in the three years of science required at the high school. Students take Biology, Chemistry, and Physics, in grades 9, 10, and 11, respectively.

Research Methods

Before data collection began, I submitted a proposal detailing the study to the Human Subjects Internal Review Board of Moravian College. After submitting a revision to the HSIRB, the proposal was approved (see Appendix A). I also submitted a proposal to the board of education at my school. The board of education and superintendent reviewed the proposal to make sure it would not cause harm to the students and would work in support of the district’s curriculum.

My study was approved by the Board of School directors on May 17, 2007. (see Appendix B)

Approval from the HSIRB occurred in the summer of 2007, so in the September of 2007, I was ready to begin the action research process in my classroom. I took a few days to get to know the students that I had in my two College Preparatory classes so I could decide which one to use for the study. I came to a decision based on the personalities of the students and the fact that I had a preparation period before the class. I began by explaining to the students that I was enrolled in a graduate education program that requires me to write a thesis about my teaching and my students' learning. I explained the action research process to the students as well as I could without overwhelming them. I distributed the consent forms (see Appendix C), which requested permission from the parents for the students to participate in the study (Holly, Arhar, Kasten, 2005). In the consent form, I included a brief explanation on what I would be doing in the classroom to gather research data. The approved curriculum of the school district's board of education was, of course, followed throughout the year. I also included in the consent form and discussed in class that all information would be stored in a secure location throughout the study and shredded as soon as the research study and development of the thesis were complete. All student, faculty, and school names were changed by using pseudonyms. I clearly explained that any students, who did not wish to participate in the study, would not be penalized for their decision. Participants in the study could withdraw from the study without penalty at any time by contacting me, my supervisor, or my faculty advisor. The appropriate contact information was listed in the consent form. I also included a consent form for my inclusion teacher, which was important since he was in the classroom and assisted me in incorporating differentiated instruction into the Chemistry classroom. Of the twenty-six students enrolled in the class, seventeen agreed to be research study participants.

The first research activity which was assigned to the students was a multiple intelligence test (see Appendix D). This test allowed me to find out each student's preferred intelligence, which would assist me in the development in lessons. Another activity that they completed was a student interest survey (see Appendix E). This survey gave me background knowledge about the student and information about the student. From the multiple intelligence test and student interest survey, I designed differentiated lessons.

I also assessed student readiness by using a K-W-L chart (Tomlinson 2003). The K-W-L chart assesses what the student knows, what the student wants to learn, and finally what they have learned. This was used to determine what information should be taught during specific units. I administered the K-W-L chart before a unit on laboratory safety, the scientific method, and atomic structure.

A pre-assessment test was also given to the students to determine their mathematical readiness. The results of the pre-assessment established how and what mathematical skills would be taught or reinforced.

Data Gathering Methods

Using these resources allowed me to differentiate instruction, according to the needs of the student. The success of the differentiation process was evaluated by using different data sources, including field notes, student surveys, student interviews, and student work.

Field log

There were numerous ways in which I collected data for this action research study. One of which was recording observations of lessons into a field log two to three times a week (Ely, 1991; MacLean & Mohr, 1999; Hendricks, 2006). I utilized a two column format in which observations that I made when the differentiated instruction was incorporated into the classroom were recorded on the right hand side of the field log. I also recorded conversations, which took place in the classroom or those which I overheard during the Chemistry class. The left side of the two column field log was used to record "observers' comments, reflections on the lesson, and to code the information obtained from the research study (Bogdan & Biklen, 2003).

Student surveys

I administered student surveys (see Appendix F) after key classroom activities including the poster/ PowerPoint project, the tombstone project, and the timeline activity. The survey was an attitude survey, which rated the students' feeling about the activity (Hendricks, 2006). I administered the surveys rather than interviewing the students due to time constraints. The questions were similar on all of the surveys and were used to determine the effectiveness of the differentiated activity.

Student Interview

Another way to determine the effectiveness of differentiation in the classroom was through student interviews. Throughout the study, I conducted informal interviews with the students during classroom activities. I also interviewed all of the students that participated in the study by pulling them out of the classroom at the conclusion of the study. I interviewed students through a semi-structured process (Hendricks, 2006). I cultivated specific questions for the interview (Appendix G), and adapted the interview based on the answers from the students. The students were asked several questions about differentiated instruction at the conclusion of the study. This data was considered when creating the theme statements.

Student Work

Hendricks (2006) suggested gathering data such as student-generated work. Student work was collected throughout the study as a summative assessment. It was used to determine the effectiveness of the differentiated activity. I photographed examples of the students' poster/PowerPoint project, the student generated scientist's tombstone project, and the timeline activity. All of these projects were evaluated by the use of a rubric (see Appendix H). Other examples of student generated work included K-W-L charts, pre and post assessment, and exit slips, which would be used to assess student readiness for an instructional unit.

Validity

According to Holly, Arhar, and Kasten (2005), it was beneficial and logical to involve the participants in the study. Allowing the students to be active participants by helping with the design of the study ensures democratic validity. As I became more familiar with the students and they became more familiar with me, informal interviews and conversations allowed me to consider students suggestions for the study. Information obtained from the students' surveys also guided the planning of instructional units. Collaboration with the inclusion teacher also occurred during the study.

As mentioned before, numerous data sources were used for this study. They include field logs, surveys, interviews, and student work. This allowed for triangulation (Hendricks, 2006). Triangulation is “a process in which multiple forms of data are collected and analyzed.” (Hendricks, 2006, p. 72) It is important to collect data from many sources, and to corroborate information across data sources. Instead of relying solely on the student work, I also observed the students during the process of creating the work. I used the rubric to evaluate the student work, the field logs, and student surveys to determine the effectiveness of the activity.

Teacher Support Group

I consulted with my teacher researcher group at least once a week at meetings and other times through e-mail. The group assisted with analyzing findings and supporting me throughout the process. They also brainstormed with me on activities I could use in the classroom. According to MacLean & Mohr (1999), the teacher researcher group not only provided support for the action research process, but served other important roles during the sometimes stressful process. The group read and discussed field logs. They assisted with analyzing data and findings. The group helped with finding results that I may not have seen without their careful reading and questioning. The teacher researcher group also disputed assumptions and findings that I found while analyzing data. Having a teacher researcher group allowed me to consider multiple viewpoints concerning the study.

This action research project was designed to improve my overall teaching and to find ways students can be successful in the classroom. During this adventure, I kept an open mind to the findings and continued to be a trustworthy researcher by following ethical guidelines according to the timeframe outline below.

Timeline for study

Spring/ Summer 2007

Researched literature and differentiated instruction, instruction in special education, and science instruction.

Wrote draft of literature review

Requested approval for the study from the HSIRB and the Board of Education

September 2007

Discussed action research with students

Passed out, discussed, and collected consent forms

Distributed multiple intelligence surveys and student interest surveys

Created and implemented poster/PowerPoint project on laboratory safety

Distributed survey on laboratory safety poster/PowerPoint

Observed and took field logs during classroom activities

Created K- W-L for atomic structure

Reflected on field logs

October 2007

Pre-assessed students mathematical skills

Implemented mathematical instruction

Assessed students after instruction

Designed instruction based on student interest surveys

Designed review based on student input

Observed and took field notes during classroom activities

Reflected on logs

Implemented tombstone activity

Surveyed students on tombstone activity

November 2007

Created timeline activity

Surveyed students on timeline activity

Coded data

Observed and took field notes during classroom activities

Reflected on logs

December 2007

Finished observing and taking field logs

Analyzed surveys

Analyzed student work

Created bins and themes statements

Made final reflection on field logs

Conducted interviews

January 2008

Began writing thesis

THIS YEAR'S STORY

Collaboration

Mr. Rockwell and I were assigned to work together at the end of the 2007 school year. When we received our schedules during the summer, we discovered we would be working together in four Chemistry classes, and we had two common preparation periods, which we could use to plan for the classes. Our roles in the classroom would be determined by the classroom activity that was taking place. Many times, Mr. Rockwell and I would co-teach. Each of us would deliver instruction to the whole class. I would also work with small groups and individual students by using the one teach- one drift method of co-teaching. This would allow me to determine the effectiveness of the lesson and to check students' understanding of the curriculum.

On Fridays, Mr. Rockwell and I determined what we would teach the students the following week. We would meet each day to reflect on the day's lesson. Often times, it was apparent students did not understand certain concepts by their body language and comments. When this occurred, I would discuss with Mr. Rockwell other ways of teaching the students. Because we had worked together in the past, it was very easy to communicate my feelings about how the class was going with Mr. Rockwell.

Getting To Know the Students

Before I could differentiate any of the lessons for the year, it was essential that I become familiar with each student's learning profile. In order to attain this background knowledge of the students, I administered a multiple intelligence survey to give me an indication of which of Gardner's multiple intelligences students used most heavily. Unfortunately, I overheard a few students saying that they had already taken the test.

Mark, for example, said, "We already did this. Do we have to do it again?"

I asked students to complete the multiple intelligence survey because not all of the students had done it and I wanted to analyze the data in a timely matter in order to differentiate instruction for the following week. Some of the students were eager to please, while others did not seem particularly enthusiastic or interested— an indication that I was working with a very diverse group. It was only the second day of class and I was feeling as if I should have waited to administer the multiple intelligence survey.

Fortunately, the multiple intelligence surveys provided much information pertaining to the students' preferred intelligences. I could not let the students' intelligences be the only way I would differentiate instruction; therefore I administered a student interest survey as well. After analyzing both the multiple intelligence and student interest survey, it was apparent that I was indeed working with a varied group of students, each coming to the classroom with quite different educational experiences. Each student was aware of what he or she liked and disliked about school. All of the students showed awareness of the ways in which they learned best.

Some students listed their preferred learning style: visual, auditory, interpersonal. Rachel reported she does not like lectures. Ashley likes working with others and working with her hands and objects. She also likes when songs link learning. Chris learns best by both seeing and doing. Kris likes to be kept busy. Melissa needs to be motivated. Sarah likes noise around. Jeff learns best by writing down notes. Lily likes when teachers give her packets of information and she also likes to see demonstrations. Matt learns best by taking notes because it helps him remember the material. Most students reported that they work best with hands on activities and having visuals, while others seem to benefit from note taking. As I planned for the study, I would look as this information and incorporate activities that would allow the students to learn in these ways. The students were not only aware of what worked for them when they learned, but also what did not work for them. The pastiche below lists ways learning does not work for the students.

Pastiche: Some ways learning ***doesn't*** *work for me!*

Auditory   Taking notes   I don't like to be bored!

Listening   Taking notes, it bores me.   I can't work in silence.

Existential because I am not interested in the powers above me.

By the teacher just talking because I get confused or distracted easily.

On the computer monitor. Explanations, boring preaches, drawn out diagrams

Hands-on I don't know.

It was obvious from the student responses that a traditional classroom, in which lecture took place was not the best teaching style for this group of students. Because the group was so diverse, I realized that I might not meet the needs of all of the students all of the time. Ways of learning that worked for one student were ways that did not necessarily work for another. Although some students learn best when participating in activities that they could use their hands, others did not enjoy or learn best by doing hands on activities. It was important to vary activities for the students in the classroom. The results from the multiple intelligence survey and student interest survey suggested to me that differentiating instruction would indeed be crucial to student success throughout the year ahead.

Differentiation According To Readiness

The first unit of the year would deal with laboratory safety. The class met five days a week with an extra laboratory period one day a week. So, the students would be participating in laboratories each week. Therefore, it was important to teach the students how to conduct their experiments safety.

To access readiness of each student in regard to their knowledge of laboratory safety, I administered a graphic organizer known as a K-W-L chart on laboratory safety. I was under the assumption that the students were familiar with filling in K-W-L charts and did not give detailed instructions. I also believed that this activity would be useful to the many intrapersonal learners in the classroom. When the students filled out the second column of the K-W-L chart, what do you want to know, the students could tell me the types of things that they would like to learn. Here I hope to give the students ownership over their learning experience. The style of the graphic organizer would assist the logical learners by presenting material in an organized manner. In the first column, the students wrote what they already knew about laboratory safety. In the second column, the students wrote questions asking what they wanted to know about laboratory safety in a Chemistry classroom. Students left the third column blank and filled it in after the lesson on laboratory safety to indicate what they had learned about laboratory safety that they did not know before the lesson was administered.

It was my plan to base the unit of instruction on what background knowledge they had about laboratory safety, which I would get from the K-W-L chart. I could design a lesson that would differentiate instruction according to readiness and learning profile. The first thing I discovered as I looked through the K-W-L charts is how little students wrote. I knew that almost all of the students had participated in laboratories last year in Biology or Chemistry, but most did not draw upon this prior knowledge. I also found that many students did not know how to fill in the K-W-L chart, since several filled in the third column, which should have been left blank until they learned something new. Looking back, I see how much students may have benefited if I had modeled how to complete the K-W-L chart. I could have projected the K-W-L chart on the board and filled in the columns with the help of the students. In the end, the K-W-L charts did not give me enough information to differentiate the next lesson according to readiness.

Creating a safe environment

Mr. Rockwell, the content area teacher, and I discussed how we would instruct the students on laboratory safety and the proper use of laboratory equipment. He suggested a laboratory on the Bunsen burner for which the students would be grouped heterogeneously. It was appropriate to conduct this activity early in the course because the students would use the Bunsen burner in many of the laboratories throughout the year. Interpersonal learners Jeff, Melissa, Cailyn, and Ashley would have the opportunity to work with other students in the classroom. Cailyn and Ashley also listed that they enjoyed working with other people on their student interest survey. James, Greg, Sarah, and Mark's multiple intelligence survey showed that they were kinesthetic learners. Although Rachel's preferred multiple intelligence was not kinesthetic, she said one of the ways learning worked for her is through hands on activities. Doug and Chris both said visuals work best for them. In order to meet the needs of most of the students in the classroom, I knew that working in the lab with one another was the logical choice. The laboratory activity would encompass many of the preferred learning styles. The interpersonal learners would be working with others in heterogeneous groups. The visual learners benefited from Mr. Rockwell and my demonstration. The laboratory procedures and report were presented in a logical way, which was suitable for students that would collect the data. Kinesthetic learners could assist in conducting the laboratory.

When the class began, Mr. Rockwell explained laboratory safety procedures, which would be followed during the Bunsen burner lab and all subsequent classroom laboratory activities. As he did this, I distributed the Bunsen burner laboratory sheets to the students. Mr. Rockwell discussed the importance of goggles and aprons before modeling how to set up a Bunsen burner. The students listened attentively as Mr. Rockwell modeled how to work a striker. Although all of the procedures were demonstrated to the students before the laboratory, instruction was differentiated throughout the laboratory with one on one and small group instruction. I modeled the procedures to the students once again and guided them step by step through the process.

Although Mr. Rockwell modeled most of the procedures in the laboratory, the students were instructed to read over all the laboratory procedures listed on the laboratory sheet. When the students were ready, they could begin the Bunsen burner laboratory. The students were permitted to select their own partner for this laboratory. The students needed to get a pair of goggles and a laboratory apron from the designated areas. The rest of the laboratory equipment could already be found at each laboratory table. Melissa had trouble and asked for help using the striker. I showed her how to hold her hand while using it, providing hints on how to do so in the future. She tried several times and then successfully used the striker. Jenny seemed to be having a difficult time lighting the Bunsen burner, so I went over to the lab table and gave her and her partner some assistance. Jenny lit the Bunsen burner and announced proudly, "I did it."

I walked around the classroom and assisted students if I saw them having trouble. I could sense Lily was having a difficult time from her body language. It made me think about something she had written in her student interest survey. She had noted, "It sounds stupid that I think gym is hard, but I'm not the best at running and I'm afraid of being hit with a basketball." As I recalled this response, I realized that if this student were afraid to be hit with a basketball, she might also be nervous about the fire. It was crucial that I make her feel safe in this laboratory setting since she would be using a Bunsen burner frequently. As Lily held out her hand and stroked the striker, I watched her pull her hand away as soon as she heard and saw the sparks. She was indeed afraid to light it. I heard her announce, "I am afraid I will burn myself." I encouraged her by telling her she could do it and would not burn herself as I demonstrated each step of lighting the Bunsen burner to her. She tried lighting it again and was successful. She smiled and looked proud of herself.

Based on observations made during the Bunsen burner laboratory, I found that every student demonstrated safe laboratory techniques. A few students needed prompting to keep their goggles on during the laboratory. I explained the importance of protecting their eyes when working with fire, chemicals, and glass. Although they seemed to understand, I anticipate that some of the students will need to be reminded of the rule in future laboratories. The students successfully lit the Bunsen burner by using a striker and gas. The students adjusted the Bunsen burner to make flame, which was the proper color and height. The students identified the parts of the flame.

After collecting and correcting their laboratory reports, I found that although all of the students participated during the laboratory, not all completely filled in their laboratory reports. I addressed this when the reports were handed out the next day. I explained how the laboratory report is a way of communicating results to the scientific community. Without this documentation, other scientists might not learn from past experiences when conducting laboratories to improve our way of life. Mr. Rockwell and I would demonstrate the next laboratory to the class, and we would show the students how we determined jobs for the laboratory.

Laboratory safety

After reading through the multiple intelligence tests and student interest surveys and observing the students during the Bunsen burner laboratory, I decided to differentiate assessment of their knowledge of laboratory safety according to student interest and learning profile. During the Bunsen burner laboratory, a few students did not wear their goggles the entire time and needed prompting to wear them. This is usually a problem that occurs throughout the year. I wanted to reinforce the importance of safety in the Chemistry classroom and hopefully the students would demonstrate these procedures during the laboratory. When looking back at the multiple intelligence survey results, many of the students were interpersonal learners. For the students to truly understand the importance of the laboratory safety, they would need to make it their own. The students would need to analyze what safety rules were most important to them. The next activity that Mr. Rockwell and I decided to implement would benefit these learners because they would be able to choose which laboratory safety rules were important to them and create a poster or PowerPoint to illustrate those rules. The activity was also designed to meet the needs of the students who learn best by doing or creating: the kinesthetic learner. The students would have the choice of whom they would like to work with on the project. We suggested but did not require that the students work in pairs, a clear benefit for the interpersonal learners. The students were also given the option to work alone. We also differentiated the materials, which the students could use to research laboratory safety procedures. The students had access to numerous texts with different readability levels as well as the internet. We also provided rubrics for both the PowerPoint and poster project.

After I handed out the rubric, I went through each with the students. This was the first time doing this project, so I did not have any examples to show the students. In retrospect, it would have been beneficial to have specific examples, so students could visually see what the final product could look like. Mr. Rockwell and I suggested that students make a plan before creating the poster. To my surprise, Sarah, Ashley, and Jamie took the suggestion. Chris and Nick re-read the lab safety contract, which was given out a few days earlier to find the appropriate rules to include within their poster. On the second day, Chris and Matt brought additional information from home. Jenny and Douglas took time to plan how they would complete their poster. Jamie and Matt were not actively involved at first, but later contributed to their group after some prompting. Throughout the process, I walked around the classroom making suggestions and critiquing their work. I talked to the students about the design of the poster. Some of the students were off task and needed to be reminded of their job in the classroom. I also assisted some students with the research process by guiding them to the appropriate materials in the classroom.

The average grade for this project was a 94, and all of the students opted to make a poster rather than a PowerPoint presentation. All of the students were successful when relating the graphics to the topic to make the poster easier to understand. The graphics were all in focus and the content was easily viewed and identified from six feet away. Most of the students created posters that were exceptionally attractive in terms of design, layout, and neatness. Capitalization and punctuation were correct. The students lost points because they did not have proper source citation for their borrowed graphics. This was not necessary if the students drew the graphics. Examples of the students' work are shown.

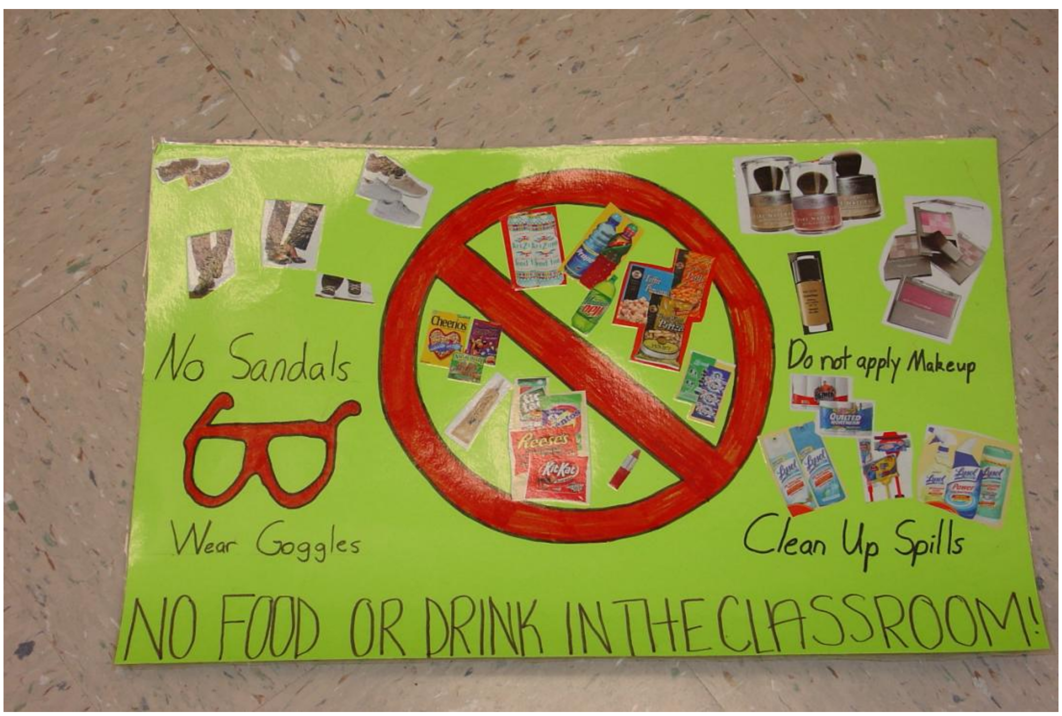

Figure1. Laboratory Safety Poster # 1

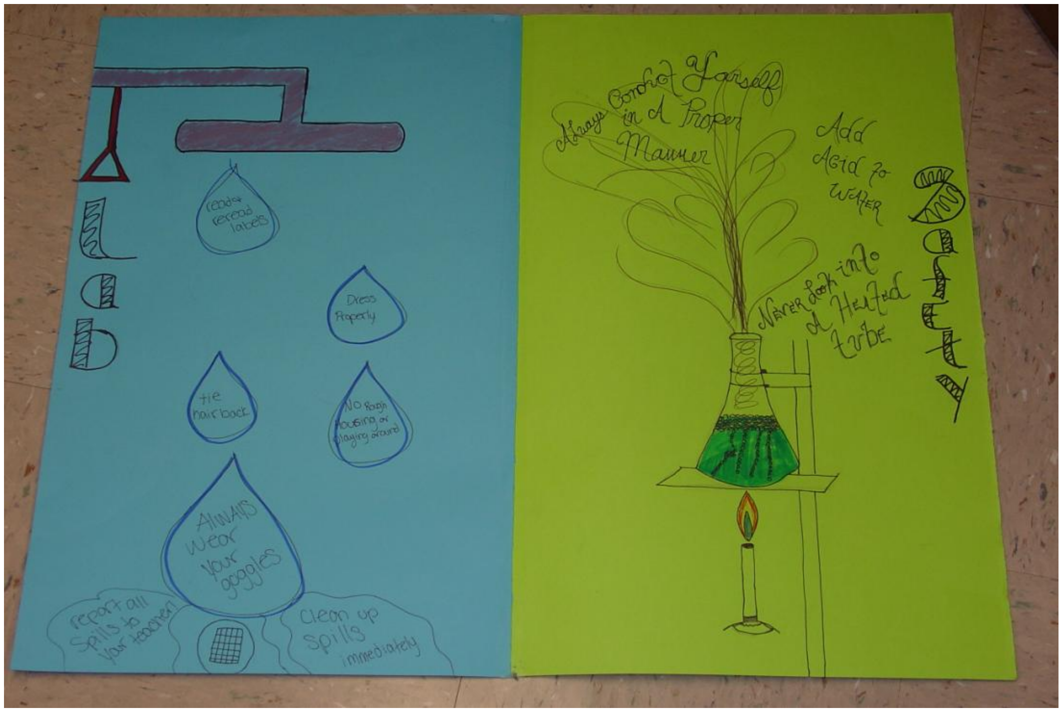

Figure 2. Laboratory Safety Poster # 2

The students who designed the first poster (see Figure 1) demonstrated an understanding of the laboratory safety rules that are important in a Chemistry classroom. The students understand that they should not wear sandals in the Chemistry laboratory. The students should always wear goggles. The students also showed that they should not have food or drink in the classroom. The students know that they should not apply make-up in the laboratory, chemical spills need to be cleaned up. The poster met all of the design criteria, but the students did not cite the sources of the graphics. By differentiating instruction, the students created a poster that showed rules that were of value to them. They also learned other procedures by looking at other student generated posters hanging in the classroom.

The students who created the second poster (see Figure 2) were also successful in learning about laboratory safety rules and procedures. This poster illustrated the importance of the laboratory safety shower in our classroom and proper use of the Bunsen burner. The students also incorporated other rules into the water droplets coming from the safety shower and gas droplets escaping from the Erlenmeyer flask. The students could use their creativity while learning about safety in the classroom. Differentiating instruction gave the students ownership of their learning.

The students demonstrated that they understood laboratory safety procedures by creating the posters. Throughout the process, I discussed the rules with them and asked the students why the rules were important to them. The students who created Poster # 1 explained how the students needed to avoid wearing sandals because they could get chemicals on their feet if they spilled onto the ground. Although the students who created poster # 2 thought the idea of using the safety shower was silly, they explained how it was important to know how to use it in case of a fire or chemical spill. The students will now have to demonstrate what they have learned when they are conducting laboratories.

Differentiation of Process

The next unit of study would deal with the scientific method, so students would need to put their laboratory safety knowledge to use on a regular basis. It was imperative that Mr. Rockwell and I collaborate on the creation of lessons to meet the needs of the learners in the classroom. We were fortunate to have worked together previously and to have two common preparatory periods where we could meet in the classroom or our offices to plan for the upcoming unit. We also worked together in four classes each day, so we had the opportunity to develop a strong relationship built upon mutual respect for one another's strengths in the classroom.

After collaborating, Mr. Rockwell and I decided to have the students conduct a laboratory which would help student distinguish between quantitative and qualitative observation, which was one of the first steps of the scientific method. The students were grouped heterogeneously. Many of the students knew the definitions of qualitative and quantitative. The following dramatization shows how differentiation of subject matter can occur even in ways that cannot be explicitly planned in advance. The dramatization demonstrates how guided questioning and scaffolding were incorporated to help students with the laboratory.

Play: Qualitative vs. Quantitative

SCENE: A high school Chemistry classroom. The students are working in pairs. Each student is wearing goggles and a laboratory apron. The teachers in the classroom are also wearing goggles and laboratory aprons.

As the students begin the laboratory, the special education teacher circulates the room to make sure all of the students have the necessary materials for the laboratory.

MARK: What does it mean to have qualitative and quantitative observations?

SPECIAL EDUCATION TEACHER: Look at the two words and tell me if you see any words within those words.

MARK: Quality

SPECIAL EDUCATION TEACHER: What kind of qualities does the candle have?

MARK: Texture.

SPECIAL EDUCATION TEACHER: What do you think a quantitative observation would be?

MARK: How much there is?

SPECIAL EDUCATION TEACHER: You are on the right track.

A common misconception about differentiated instruction is a teacher should differentiate instruction for all students in the classroom for every activity. In this laboratory, differentiation occurs only with two students in the classroom. This differentiation leads to success in the laboratory as students begin to distinguish qualitative from quantitative data.

Overall, the students were all actively engaged in the lab. They asked many interesting questions and made important observations about the candle. The students efficiently collected all of the materials for the lab and documented their observations appropriately. The students did not completely finish their laboratory report, and most missed one question about inferences. Groups seemed to work out well for this activity. The average grade for the laboratory was an 88.

I wanted to see if the students enjoyed working in groups for this activity or if additional direct instruction may have benefited the students. I also wanted know if grouping is an activity that would benefit the students. I created a survey to answer these questions. Students responded, as follows:

Table 1: Cooperative Grouping Survey (N = 15)

Question	Agree	Partially agree	Hardly agree	Disagree
1. I would have liked it if the teacher taught the whole class.	2	5	2	6
2. The teacher did not help us enough.	0	2	3	10
3. I have learned a lot by working in the group.	10	3	2	0
4. I did not like working in a cooperative group because I had to do too much work for my group.	1	0	2	12
5. I was confused when working in the group.	0	0	3	12
6. I like working in the cooperative group because I could work with many different people.	10	4	1	0
7. I had a hard time organizing my work when working in the group.	1	0	3	11
8. Using different teaching methods makes our lessons fun and less boring.	9	6	0	1
9. I like to work in a cooperative classroom again.	13	2	0	0

The results of this survey emphasize the fact that the students prefer to learn in different ways. Although the results of the first question varied, approximately 87% of the students indicated wanting to work in cooperative groups again. The survey suggested to us that as we design future instruction we create lessons that allowed the students to work in cooperative learning groups. Since the students enjoyed working with many different people, the groups could be changed according to the purpose of the activity.

Differentiation according to interest

When the first unit of study ended, it was time to summatively assess the students. To do so, Mr. Rockwell developed a test for the unit. I reviewed the test to ensure it was appropriate for all of the students in the class. I created a study guide based on the test to administer to the students. The students would complete it overnight and as a class, we would go over the materials in order to prepare them to demonstrate what they knew and were able to do as a result of participating in our first unit's activities.

I had already created and administered the study guide to the students when I decided to ask for their input. Somewhat on a whim and a day before the review session, I asked the students about their review preference.

"Are we going to play a review game?" shouted Melissa.

I asked the students to raise their hands if they preferred to review in this way. Almost of their hands went into the air. Mr. Rockwell and I had not considered this option since students had access to the study guide.

The next day I explained the rules of the game to the students before dividing them into heterogeneous groups according to their laboratory tables. Mr.

Rockwell controlled the computer, as I kept score and read the questions to the students. The students still had the study guides, which mirrored the *Jeopardy* style review. As they played the game, some of the students feverishly wrote down the answers to the questions for the review, and others became quite agitated when they did not have enough time to write down all of the answers.

Since the students were the driving force behind creating the Chapter 1 review, I decided to see if they enjoyed it and how they felt it was beneficial to them, so I administered a survey to them (see Appendix F). All but two students felt that reviewing with *Jeopardy* helped them retain more information about the chemistry topic. Some of the students realized that the questions would be similar to the questions on the test and stated that they wanted to know the answers. Although Cailyn liked playing the review game, she noted that she could not write down the questions fast enough. One student said that it helped with questions that he had because he had been absent. Others looked at the fun aspect of the review game. Chris would have preferred to pick teams than to be "stuck with" his laboratory table. Almost all of the students would like to use the game as a way to review for tests again, reinforcing the fact that not all instructional techniques work for all students.

This activity was differentiated so the students could have fun while reviewing for the assessment. I found that although the students wanted to have fun during the review, they were also very worried about getting all of the information written down, suggesting to me that most of the students were genuinely concerned about their achievement in the classroom. I was also glad the students had the study guides to support them as they prepared for the unit test.

The average grade for the Chapter 1 Test was a 74. Almost all of the students did well on the problem solving section of the test. Most of the students did not do well on questions that pertained to the scientific method. Mr. Rockwell and I agreed that the students might retain this information if it were actually used during a laboratory.

Mathematics in Chemistry

After completing the unit on the scientific method, Mr. Rockwell and I discussed the content of the next unit. According to the text, students would go on to study mathematical concepts they would need to use later in the course. I suggested that we instead instruct the students when they would actually need to use the math. I felt it was useless to instruct them in it, if they would not be using the concepts. I worried that if the students did not immediately apply the information, they would not be able to recall it or transfer it when needed in the future. Although Mr. Rockwell was sympathetic to my argument, he insisted that we teach the concepts in the traditional manner, yielding to pressure to follow the district's curriculum map. In the end, Mr. Rockwell and I came to a compromise about the instruction.

We planned to assess the students' readiness by administering a pre-assessment on the mathematical skills: significant digits, scientific notation, dimensional analysis, solving for a variable, and formula use. I would use the results of the pre-assessment to differentiate the instruction according to the students' readiness by creating learning centers and conducting mini mathematics seminars. If the students did not do well with particular mathematical skills, they would attend the mini mathematics seminar and receive small group instruction. If the students did well on the pre-assessment, they could complete an independent study or strengthen their mathematical skills with challenge problems. These mathematical skills would be used throughout the year, so it was imperative that students began with a strong foundation. I was under the impression the students would perform well on the assessment because I assumed that the students had learned many of these skills in prior years. Unfortunately, the results of the pre-assessment showed that the students were not familiar with many of the concepts. The students could solve for a variable and engage in problem solving with formulas, but most did not understand significant digits, scientific notation, or dimensional analysis. Mr. Rockwell and I discussed the pre-assessment results and both agreed that whole group instruction would benefit most students. As he was teaching, I assisted the students in small group or one on one instruction as needed. I would write the steps of problems out for the students. I would also make up more practice problems for the students. Some students asked specific questions about problems like, "What do you do with the exponents when multiplying scientific notation?" Based on our pre-test data, we also decided that a review of the metric system was in order.

During this unit, the students were given PowerPoint notes, which were projected on a screen from an LCD projector. The students received a skeleton note page on the metric system, which they filled in as we presented the notes. This is a differentiation of content according to learning profile. The visual learner would be able to see visual representations of key concepts. Filling in the note packets was useful for the kinesthetic and logical learners. The auditory learners benefited from hearing the class notes being discussed. During the instruction, the interpersonal learners were given the opportunity to work on practice problems at their lab tables. Most of the mathematical skills were also taught in the same manner. Differentiation took place during the independent practice. The students who understood the mathematical concepts were given problems that were more challenging. The students who had difficulty with the topic were re-taught in small group or individually.

To introduce the topic of significant figures in the class, Mr. Rockwell and I introduced what we called the Atlantic Pacific Rule. Mr. Rockwell led the class as I walked around the room and assisted other students. After drawing an outline of the United Sates on the board, Mr. Rockwell explained the rules. If the decimal was absent, the students started on the Atlantic side and counted at the first non-zero number. If the decimal was present, the students started on the Pacific side and counted at the first non-zero number. Mr. Rockwell showed the students a few examples. He then wrote problems on the board and the students solved them with his prompting. Finally, he gave the students independent practice problems. I overheard Sarah say, “This is easy. Why don’t other teachers teach it this way?” Using the mnemonic device was useful for our visual learners. Mr. Rockwell and I discussed the relationship between significant figures and the precision of measuring instruments. We felt the students should know how to determine the number significant figures when calculating mathematical operations.

To evaluate the effectiveness of the instruction, I compared the number of students’ correct answers on the pre-assessment to the number of students’ correct answers on the post-assessment. The results are presented in the table on page sixty-five. The students did significantly better on the post-assessment. When the students completed the pre-assessment, I could see that many of the answers were guesses because many did not make sense. While not all students arrived at the correct answer on the post-assessment, the answers showed the students were beginning to learn the mathematical process. For example, students did not write down all of the significant digits when solving a scientific notation problem or the students mixed up the signs on the exponent parts of scientific notation. Another common mistake occurred when the students multiplied exponents instead of dividing them or they added the exponents when they should have subtracted them. Overall, the students improved with the mathematical concepts used in Chemistry. Whole group instruction proved to be beneficial to the students for this particular topic. Although my intention was to differentiate instruction with learning centers, I found that whole group instruction with small group instruction worked successfully.

Table 2. Mathematical Pre-assessment vs. Post-assessment (N=15)

Type of question		# correct on pre-assessment out of 15	# correct on the post-assessment out of 15
1.	Significant digits #1	0	11
2.	Significant digits #2	1	14
3.	Scientific notation #1	5	10
4.	Scientific notation #2	6	11
5.	Scientific notation computation #1	5	13
6.	Scientific notation computation #2	1	4
7.	Dimensional analysis #1	1	12
8.	Dimensional analysis #2	0	12

Whole group instruction

At this point in the year, Mr. Rockwell and I wanted to be further along in the curriculum sequence than we were. We decided that due to time constraints we would not show the movie clips on energy and matter that we had planned. Instead, we prepared PowerPoint graphic organizer for students to use as we introduced energy and matter. We were attempting a differentiation of content according to readiness and learning profile. Matt and Jeff, for example, learned best by taking notes. Lily confided that she learns best when she is given a packet of information that has been organized for her. Although Melissa indicated that taking notes bores her, Mr. Rockwell and I were sure to incorporate physical property demonstrations as part of the note taking process. As we were exploring mixtures and pure substances, for example, I showed the students salad dressing, a heterogeneous mixture.

Melissa said, "You brought your salad dressing in for me?"

As Mr. Rockwell forged ahead, he showed the students mothballs, an example of a compound. We continued through the lesson showing numerous examples, including corn syrup, table salt, and Calcium chloride. This whole group instruction allowed us to share a great deal of new information in ways that were far more meaningful to students than standard lecture alone.

I found that the use of PowerPoint notes and the examples was useful to the students. When the students were asked to give examples of mixtures or solutions, the students often times listed the examples that we had given in the notes and demonstrations. The students also listed them in their notes. In an informal interview, the students stated that the note packets helped them to know what was most important in the unit. A few students suggested the notes be in outline form, a suggestion I would take this into consideration when I was preparing the next unit.

Tombstone Activity

After the students completed an energy lab, I introduced the tombstone project, which was intended to support differentiation of product according to learning profile and interest. Students examined the lives and discoveries of important scientists. The students created a tombstone for a scientist from Chapter 3 of their text or a teacher approved alternative. I provided a project information sheet and a rubric detailing what was expected for the project. On the front of the tombstone, the students included the name of scientist, his or her picture, dates living, a five sentence epitaph, and decorations. The back was to include a short paragraph about the scientist with a works cited. Students had three weeks to complete the project, which was to be done primarily outside of the classroom.

One student identified the major contributions of Benjamin Franklin to the scientific community (see Figure 3). He included Franklin's research on static electricity and Franklin's invention of the electrostatic machine. The student also explained Franklin's famous kite experiment. He listed numerous scientific terminologies, which are still used today. He also incorporated some of Franklin's personal information; he created a tombstone, which was creative and original. The tombstone listed appropriate sources of research.

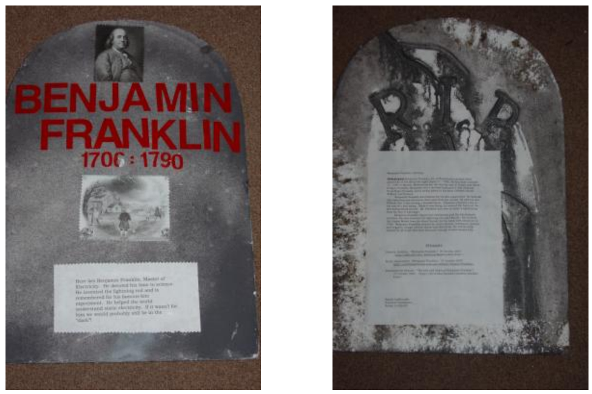

Figure 3. FranklinTombstone

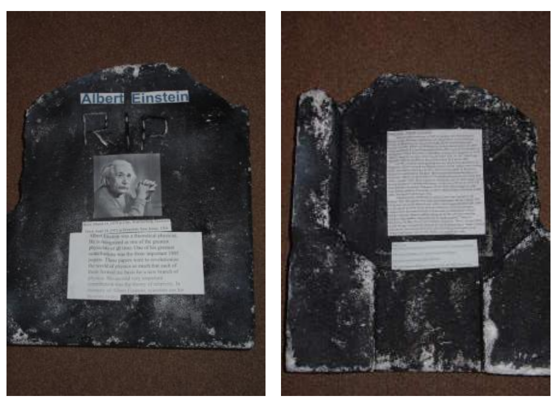

Figure 4. Einstein Tombstone

Another student included information about Albert Einstein's 1905 papers on the front of the tombstone (see Figure 4). The student also included three well developed paragraphs about Einstein, including background information. He also included information on the photoelectric effect, the space-time continuum, and the Theory of Relativity. The tombstone was creative and original, listing several sources of research.

Overall, students demonstrated the ability to creatively design three-dimensional tombstones that included the major contributions made by scientists. They developed their content area literacy skills by researching and creating a biography that followed the conventions of standard English. The area most difficult for the greatest number of students was citing the sources used for their research which surprised me because the students had been taught how to this in other classes.

After the projects were turned in, I displayed them in the class. During laboratory periods, the students walked around and looked at each other's work, taking them down from the ledge and discussing them with one another.

Historical Figures

The second unit of College Preparatory Chemistry focused on the structure of matter, which included the atom, parts of the atom, atomic mass energy levels, atomic spectra, quantum numbers, atomic orbitals, periodic relationships, groups, periodic law, configurations, and historical background. Students compared and contrasted the contributions of scientists towards the development of the quantum mechanical model of the atom. Students categorized subatomic particles and distinguished between physical and chemical properties and changes. They completed electron configurations of the first 20 elements and selected transition metals. Students also determined an element's position on the periodic table according to its properties.

When the students entered the classroom, they found both outline notes and the PowerPoint slide organizer on their desk. The students chose the packet which was best for them. Mr. Rockwell started the instruction with a Do Now activity. In order to motivate and interest the intrapersonal learners, the students were asked, "How do you think scientists come up with their ideas? Do they collaborate or do it alone?" As the students completed this activity, I checked their homework, a K-W-L chart on atomic structure, which would be used to assess readiness. After I went around the classroom and checked both the Do Now and the K-W-L chart, we discussed the atomic structure K-W-L. I asked the students what they knew about atomic structure.

Sarah said, "Protons, neutrons, and electrons."

Several other students gave answers to this question and added what they want to know. We then discussed the do now.

Sarah said, "I think the scientists collaborate on ideas."

Cillian added, "The scientists collaborate if there is group funding."

After the discussion, we started the unit. I now had an indication of the students' prior knowledge and shared what I had learned with Mr. Rockwell. We presented several scientists including Democritus, Lavoisier, Proust, and Dalton, all of whom made major contributors to the understanding of atomic theory. Mr. Rockwell went on to introduce Thompson's cathode ray tube experiment. To assess the students' comprehension of the lesson, we passed out exit slips, which asked the students to list Dalton's postulates. All of the students were successful in listing the postulates. The students were assigned a reinforcement worksheet to assist with retaining information on the scientists. As the students worked, I distributed flashcards with important facts about all of the scientists we would go on to study in the unit.

The next day, Mr. Rockwell and I began with another Do Now activity, this time a question from the previous day's notes that all of the students should be able to answer. We asked, "What is an atom," and students began to work as soon as they entered the classroom. After discussing the Do Now and the homework assignment, Mr. Rockwell did a demonstration of Thompson's Cathode Ray tube experiment and Rutherford's gold foil experiment, using a straw to shoot navy beans at a tin tray covered with yellow tissue paper. The students enjoyed seeing this demonstration of Rutherford's experiment in action. Many laughed and all of the students were attentive. As the paper ripped, we could see something in the center and asked the students what part of the atom Rutherford had discovered.

Doug said, "The nucleus."

Kris added, “The nucleus with the protons and neutrons.”

I showed the class another reenactment of this experiment on the PowerPoint and again all of the students were attentive when watching this demonstration. After the demonstration took place, we discussed what had happened in the experiment. Nearly all of the students raised their hands to answer the questions. Many students shouted out answers. Although most of the students showed they understood the significance of the activity by volunteering answers during our discussion, we assigned a reinforcement activity on the topic.

In order to review the major contributions of scientists toward the development of the atomic theory, I created a game of I Have, Who Has, in which each student received a note card with a scientist’s name written on one side and another scientist’s major contribution on the other. I picked a predetermined student to start, who said, “Who has the scientist that discovered the nucleus of the atom by conducting the Gold Foil Experiment?” All of the students were attentive because they had to check their cards to determine if they had the answer. One student shouted out, “I have Ernest Rutherford.” Then that student read the back of the card. This continued until all of the cards were read. Some students assisted other students at their table.

Despite our best attempts to support student learning throughout the unit, most students did not score well on the multiple choice quiz, where the average grade was a 70. The students had difficulty matching the scientists to their contribution. The students could identify that Rutherford conducted the gold foil experiment, but they could not explain that Thompson proposed the "plum pudding" model of the atom. Surprisingly, the students could not identify that Thompson conducted the cathode ray tube experiment. We had demonstrated this experiment to the students. The students could not identify who proved the existence of a negatively charged particle. This made me wonder if the students understood that a negatively charged particle is an electron. Mr. Rockwell and I would need to re-teach this information. The students could not identify the scientist who established the "Law of Conservation of Matter," but understood that Lavoisier proposed that matter contains atoms which cannot be created or destroyed. The students did not link the name of the theory to what the theory explained. Mr. Rockwell and I discussed the results of the quiz and created an activity that would follow up on this information.

To reinforce the scientists, Mr. Rockwell and I adapted an activity from discovery school. The students were divided into pairs and groups of three based upon prior academic performance, ensuring the presence of what Vygotsky might call a more knowledgeable other.. The students examined how significant scientific theories are developed. They explored the work of scientists who contributed ideas to the field of atomic theory. The students developed a timeline of key scientists to show how the work of each one built on the efforts of those who came before him. I was hoping that if the students saw the scientists in sequential order it would help them understand that one discovery could not be possible without the other. The materials needed for this activity were computers with Internet access, texts with various reading levels about the history of the our understanding of the structure of the atom, construction paper, time line paper, colored pencils and markers. The groups of students researched the ten scientists assigned, including Democritus, Lavoisier, Proust, Dalton, Faraday, Franklin, Thompson, Millikan, Rutherford, and Bohr. We provided websites with varying readability levels for students to use to find information. The students could also use information found in their notes. From their research, the students created a timeline including the scientists and their theories. Once again, the students were assessed using a rubric.

I did not think this activity would take more than one period, but as the students worked, I saw that they would need more time to research the scientists and create their timelines. I also learned how crucial it is to have every detail of the activity written out for students in advance of the activity. During the first day, the students needed small group instruction. If I were to incorporate this activity in the future, I would also use part of the time instructing the students on how to research. I erroneously assumed that the students were familiar with conducting internet research, and most were not.

The second day proved to be more successful as students continued and finished their research. As some students in the group were researching, the other students began to create the timelines.

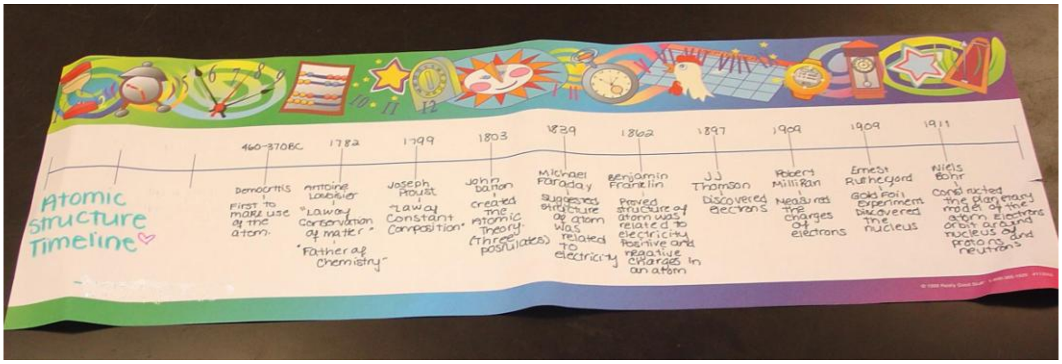

Figure 5. Atomic structure timeline #1

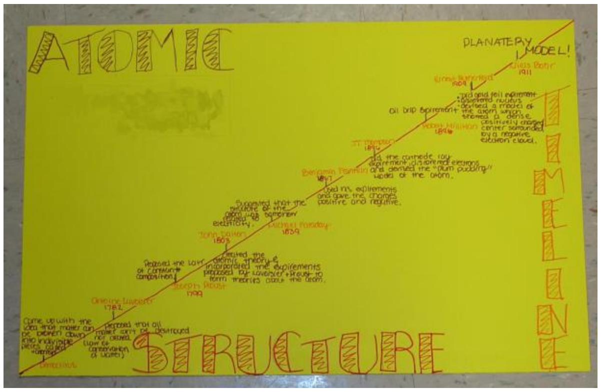

Figure 6. Atomic Structure timeline #2

The students demonstrated an understanding of how important scientific theories are developed (see Figure 5). The students listed each scientist with his accomplishment. The students did not provide details for Democritus, Lavoisier, Dalton, Thompson, and Proust. The students worked well with their group to conduct internet research, and were highly involved in the development of the class timeline.

The students demonstrated a deep understanding of how important scientific theories are developed (see Figure 6). The students listed all of the scientists and their contributions but lacked detail with Proust, Dalton, and Millikan. The students worked well with their group to conduct in-depth research; and were highly involved in the development of the class timeline.

The students were successful when creating the timelines. The material was reinforced and would be assessed with a test on the unit.

I wanted to see if the students enjoyed working in groups for this activity or if directed instruction would have benefited the students. I also wanted to know if grouping is an activity that would benefit the students. I created a survey (see Appendix J) to answer these questions. The students completed a survey after this activity. When I analyzed the surveys, I discovered the results in Table 3.

Although half of the students did not prefer that we teach the whole class, the other half of the class would have preferred if the teacher instructed the whole group rather than work in groups (see Table 3). Most of the students learned a lot by working and researching with their group. Almost all of the students agree that using different teaching methods makes the lesson fun and less boring. This activity was used to reinforce the material taught in class. From the survey results, the students showed that they enjoyed the activity. Making sure I scaffold instruction, I would use this timeline activity in the future.

Table 3: Timeline Survey (N= 12)

Question	Agree	Partially agree	Hardly agree	Disagree
1. I would have liked it if the teacher taught the whole class.	1	5	2	4
2. The teacher did not help us enough.	0	2	2	8
3. I have learned a lot by working and researching with a partner.	7	2	3	0
4. I did not like working in a group because I had to do too much work.	0	2	1	8
5. I like the timeline activity because I could work with many different people.	9	2	0	1
6. Using different teaching methods makes our lessons fun and less boring.	9	2	0	1

At the end of the unit, we gave students a study guide for the atomic structure test. The test consisted of matching, multiple choice, and short answer. The test included information on atomic structure and historical figures. The students' average grade for the test was an 82. Eleven of the 34 questions pertained to the historical figures. The students did significantly better on the historical figure section of the test. The atomic structure portion of the test would be reinforced in forthcoming chapters. Using different ways to teach the material seemed to be beneficial to the students.

Periodic Table of Elements

Mr. Rockwell and I collaborated on the next chapter, the development of the periodic table and how we would approach it. I suggested an activity (see Appendix K) that would give the students choice and would accommodate different learning styles.

Mr. Rockwell did not see the significance of the activity. Although he had been very supportive throughout the year, I had a difficult time convincing him that differentiated instruction might replace traditional instruction on this topic. He felt that if we would do a differentiated activity, we still had to give the students notes and test them in a traditional way. He was also concerned again with time. It was November and we were already a month behind where we intended to be. Unfortunately, we did not administer the activity.

Differentiation in the future

Formal data collection ended on November 21st, 2007. The students in the course would continue to increase their knowledge of scientific processes by learning about bonding, stoichiometry, gases and the kinetic molecular theory, properties of solutions, acids and bases, redox chemistry, kinetics and thermodynamics, and organic chemistry. As we made our way through the Chemistry course, I would continue to find ways to differentiate instruction.

Using a jigsaw activity in any section would allow me to differentiate instruction according to readiness. It would also allow me to put the learning in the hands of the students. Each student could become an expert on a particular topic and teach the information to their group. The students would also have the opportunity to contribute to the creation of their assessment.

METHODS OF ANALYSIS

Throughout the process of gathering data, I continued to analyze my data in an ongoing fashion by re-examining previously written field log entries. I wrote reflective memos, listing questions or realizations that I had not considered when the observations were initially documented.

Bogdan and Biklen (2003) suggest writing memoranda throughout the study to analyze what has occurred, leading the researcher to new ideas and questions. According to Ely et al. (1997), it is necessary to analyze our data from different perspectives in order to ascertain new meanings. I did this by reading works from Delpit (2002), Dewey (1938), Freire (1970), and Vygotsky (1978) as I was gathering data. I took into consideration their different foci, gender, race, linguistics, progressive education, dialogics, and the zone of proximal development while analyzing teaching methods used in my classroom. I wrote reflective memoranda about the educational theorists' ideas and how they related to my classroom throughout the duration of my study.

During the process, I also completed a figurative language analysis, locating several metaphors in my field log. Lakoff and Johnson (1980, p. 193), believe "metaphor is one of our most important tools for trying to comprehend partially what cannot be comprehended totally." I analyzed both the intended meaning of the speaker and the literal meaning. From that, I analyzed what significance there was for my study.

Creating a pastiche allowed me to document information that is important to my study in a more concise way. A pastiche contains "various textual experiments that link data, descriptions, analysis, or multiple genre into diverse configurations, demonstrate how form affects meaning" (Ely et. al, 1997, p. 96). I choose to incorporate a pastiche to emphasize the diversity of learners in my classroom by sharing comments from the students. In the paragraph previous to the pastiche, I wrote about the ways learning has worked for the students in the past. I followed this with a pastiche on how learning does not work for the students. This allowed me to take into consideration what worked and did not work for the students. Using these multiple perspective, I developed lessons based on the students' views.

Dramatization is a way to display key events that take place in the classroom that are significant to the study. While writing my story, I noticed that a section of my field log contained a large portion of dialogue between the students and me. I analyzed this event to see if it would have any relevance to my study. When I discovered the importance of the dialogue, I chose to illustrate what was going on in the classroom through a dramatization. It allowed the reader to become a part of my classroom. I could see the importance of differentiating instruction in the classroom.

I also coded the field logs (Ely et al., 1997). Coding allows the researcher to "break down data into manageable chunks" (Ely et al., 1997, p. 205). When I differentiated instruction according to readiness, for example, I wrote READINESS in the left column of my two column field log. I went through the logs several times to make sure I did not miss any information by not coding it. During the process of documenting observations in the field logs, I created an index of the codes. In a table, I listed the codes in alphabetical order in the first column and placed the corresponding field log page numbers in the second column.

When most of the observations were documented and coded, I organized the codes into a graphic organizer (Ely et al., 1997). I listed main ideas found in the field log into bins. This organizer was the first visual representation that summarized the main points of the study.

Having a visual representation allowed me to analyze the data to develop theme statements. Creating themes is “a process of sorting through the fabric of the whole for our understanding of the threads or patterns that run throughout and lifting them out- as a seamstress lifts threads with a needle” (Ely et. al., 1997, p. 206). From the bin graphic organizer, I created theme statements that provided answers to my research question.

I also analyzed the multiple intelligence and student interest surveys to obtain background information on each student in the classroom. As I continually reviewed the survey results, I used the information obtained from them to guide the development of differentiated lesson plans.

Surveys, which I distributed to the students, helped me to learn the ways in which an activity was successful. This allowed me to determine if I would use the instructional technique in the class again. The results would also support other quantitative data such as assessment scores collected in the study.

FINDINGS

Throughout this study, I have learned many things about my classroom and the students in it. I found a way of incorporating different teaching techniques to meet the needs of all of the students in the classroom as I differentiated instruction to the best of my ability.

First, *scaffolding is essential when instructing students to assist them with mastering course content.* While scaffolding it is essential that instruction occur in what Vygotsky (1978) terms the zone of proximal development, "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with capable peers" (p. 86). The zone of proximal development is the difference between what a student can learn independently and what can be learned by working with more knowledgeable others in the classroom.

I made many assumptions on what students could and could not do independently throughout the study. When I failed to provide sufficient scaffolding, students were not nearly as successful at meeting my objectives as they were when I provided this support. This was apparent when I administered a K-W-L chart to the students in the classroom to assess their readiness on topics. Because students had claimed to have used them before, I assumed that all of the students were familiar with K-W-L charts and no further scaffolding would be necessary. When I collected the first set of K-W-L charts, I did not obtain as much information from them as I thought I would. The students wrote down words or phrases and did not provide details. Students filled in the “What did you learn column” even after I had told them not to because I had not instructed them on the information. Some students did not fill in columns or wrote things like “I don’t want to learn anything.”

The second time I administered the K-W-L, I drew a sample chart on the board and modeled how to fill it appropriately. I gave an example of what I knew about the scientific method and wrote it on the board in the “What I know” column. The students provided examples of what they knew about the scientific method. I wrote each example in a complete sentence. I discussed the next column, “What I want to learn” with the students. I explained why it is unacceptable to write I don’t want to learn anything. I wrote an example on the board and the students provided their examples, which I wrote on the board. The students finished it for homework. I went on to use this K-W-L charts to assess readiness and incorporate those items students indicated wanting to learn.

The students filled in the “What I have learned” column at the end of the unit. I collected the K-W-L charts and found that most of the students properly filled it out, but did not add to the information we provided in class. The students were also very vague on what they had learned in the chapter. Hence, while my own use of scaffolding was improving, students continued to need guidance through each stage of the process.

The next K-W-L chart was administered during the atomic structure unit. This time we discussed the purpose of the K-W-L chart in detail. When I collected the charts, I found that the students were becoming familiar with the charts and the students were giving me much more concrete information about their learning, which would guide instruction. From the start, I should have scaffolded instruction on how to fill in the K-W-L chart with the students. Clearly, scaffolding instruction is necessary in the classroom, and this study has taught me the need to scaffold even when I may not initially believe that it is necessary to do so.

Providing a safe and positive learning environment leads to positive student affect. Stronge (2002) suggests that effective teachers create a supportive environment. A major component of differentiated instruction is affect. I emphasized the importance of respecting each other in the classroom. I tried to make the students feel comfortable. It was important to create a community of learners, who valued each other's contributions to the classroom. Mr. Rockwell and I showed respect for each other while teaching in the classroom. Students were cognizant of this and demonstrated the same respect to each other in the classroom.

I tried to create a positive affect from the beginning of the year by creating a classroom environment conducive to learning. I arranged various texts around the classroom. The laboratory was outfitted with the mandatory safety equipment. The course procedures and practices were outlined to the students on the first day of class. The students' work was displayed throughout the classroom making it their own.

The safety of the students is crucial in a Chemistry laboratory. I tried from the start to ensure students that their safety was of the utmost importance to me. Although many of the students had been instructed on laboratory safety and procedures, it was essential that the students understand the proper procedures for a Chemistry classroom.

During the Bunsen burner laboratory, many students showed that they did not feel safe using the burner. I modeled the proper use of the equipment and gave positive praise to the students when it was appropriate. I believe that support during the laboratory helped create a safe and positive learning environment.

I also believe the students felt comfortable in the environment because I would ask the students questions about their own learning. The student interest survey gave me a plethora of information about the students, and I used this information as vehicle to initiate conversation. When the students realized I took the time to read about them, they were assured that I cared about their individual success.

Differentiating instruction according to learning profile is essential to promote academic achievement. Our classrooms are filled with students who have diverse learning needs due to learning preferences, background knowledge, and other factors. "That children's learning begins long before they attend school in starting point of this discussion. Any learning a child encounters in school always has a previous history" (Vygotsky, 1978, p. 84).

It is the teacher's job to gauge students' background knowledge and differentiate instruction appropriately. Traditional lecture classrooms do not meet the needs of too many students in the classroom. In a traditional classroom, "education thus becomes an act of depositing, in which the students are the depositories and the teacher is the depositor" (Freire, 1985, p. 58). For many students, learning will not occur in this type of classroom because they are not a part of the experience.

One component of learning profile is the way in which students learn. I found from administering a multiple intelligence survey that many of my students were kinesthetic learners. With this knowledge, I created activities to gauge this learner. I created laboratory activities that allowed the students to have a hands on approach to learning. The students also created posters and other projects that benefited this type of leaner.

Teachers need to use the resources around them to become familiar with the students in their classroom. I talked to other teachers and guidance counselors about the students' academic backgrounds. School records were also used to collect data on the students. Individual education plans provided me with the accommodations and modifications, which would be applied in the classroom. Multiple intelligence surveys and student interest surveys were administered to the students (Tomlinson, 2003). Throughout the study, I examined student work and assessments. By doing so, I discovered the concepts students mastered in the classroom. Using all of this information, I designed lessons in the classroom that allowed for student achievement and motivation.

Differentiated instruction is a crucial component of successful teaching. "It is theoretical construct that rests on three propositions: Successful teaching focuses on students' academic achievement, successful teaching supports students' cultural competence, and successful teaching promotes students' socio-political consciousness" (Ladson-Billings, 2002, p. 110-111). Ladson-Billings proposes three principles for successful teaching that will allow all students to achieve academic success. The students will develop academically and understand new scientific concepts. Teachers will respect cultural differences and these differences will be appreciated by everyone in the classroom. Lastly, students and teachers will work as a community respecting each others' backgrounds. Differentiated instruction is instruction that meets the needs of all children no matter their learning differences, cultural difference, or socio-economic differences. The principles outlined by Ladson-Billings support differentiated instruction in the classroom.

Differentiated instruction can lead to academic achievement. The basis of using differentiated instruction in the classroom is to find instruction that meets the needs of all students, which ultimately leads to academic achievement. When differentiating activities during the study, I found the students were successful academically. Students who benefited from the traditional classroom had the opportunity to excel academically when direct instruction occurred. The students who did not score well on assessment could be successful with projects and alternative assessments. Student comments and grades reflect the success in this classroom.

Student input and preferences lead to more effective instructional differentiation. When instruction is thrown at the students and does not connect to the students, they lack motivation to learn. “His task is to ‘fill’ the student with contents of his narration-contents which are detached from reality, disconnected from the totality that engendered them and could give them significance” (Freire, 1985, p. 57). Here Freire explains the banking model whereby the teacher’s job is to deposit information to the students by reciting, which does not relate the information to the real world, stimulate the student, or possess meaning.

By accepting student input for learning, students are motivated to learn. I took suggestions from students as I developed lessons. Throughout the study, I administered surveys after certain activities. In the survey, I asked the students if they would like to do this type of activity again. I used that information when planning other lessons. The students enjoyed working in small groups, but wanted to choose their group. I allowed for this in the timeline activity.

Assessing student readiness through different means is useful when planning and differentiating instruction. Many assumptions can be made about what knowledge the students bring to the classroom or what information students are retaining in the classroom. Assessing student readiness gives an indication of where and what materials, teachers should use in the classroom. I did this in a variety of ways; K-W-L charts, pre-assessments, do now activities, and exit slips.

When administering a pre-assessment on mathematical concepts, I found that many of the students did not have a strong foundation with the concepts. I reflected upon this and determined that whole group instruction with small group and one on one instruction was most beneficial to the students. After the students were instructed on the concepts, they were given a post-assessment, which should the students were successful academically.

"In the banking concept of education, knowledge is a gift bestowed by those who consider themselves knowledgeable upon those whom they consider to know nothing" (Freire, 1985, p. 58). The banking concept of education assumes that the students of the teacher do not have any background knowledge on the subject. The teacher is teaching a blank slate and can dump all of the information into these receptacles. All students come to our classrooms with some background knowledge. Teachers can assess the students' readiness of the topic and based on these results, students can work according to their readiness. The students can be group with students with the same readiness or with varied readiness levels.

Building a strong and respectful collaborative partnership between content specialist and special educator is necessary for any inclusive program. Mr. Rockwell and I had a mutual respect for each other and our expertise and this was evident in the classroom (Friend, 2007). We discussed our classroom before the students came to us (Murawski & Dieker, 2004). We created a syllabus that outlined all classroom expectations and procedures. After administering the multiple intelligence tests and student interest survey, Mr. Rockwell and I discussed the results. From the results, we created activities such as the laboratory safety posters and three dimensional scientist tombstones to meet the needs of our kinesthetic, interpersonal, and intrapersonal learners. We found that whole group instruction supplemented with small group and individualized instruction met the needs of our students in some situations. Because of our experience working together and our established relationship, we decided that most of our instruction would occur in the team teaching model. Other instructional model would occur as we deemed necessary. They included parallel teaching and one teach- one drift (Friend & Bursuck, 2002).

Planning for the class was also essential. Mr. Rockwell and I used at least one of our two common preparatory periods to plan instruction for the preceding week. After activities, we took time to reflect and discussed the successes and failures of the lesson. This took place during our preparatory periods or after school. We indicated the progress of the students to the parents at least bimonthly by jointly completing reports.

During the study, we evaluated test scores and determined the appropriate course of action for the students (Murawski & Dieker, 2004). The students were assessed on the historical figures with a multiple choice quiz. The results of the quiz were not at all what Mr. Rockwell and I expected. After discussing and reflection, we decided to reinforce the concepts by differentiating the process. The students created timelines. Our hope was that the students would research to find out more information about the historical figures. From that research, they would make a timeline which sequentially documents the discoveries. The students were later assessed on the historical figures and achieved success.

Throughout the study, Mr. Rockwell and I did not always see eye to eye in all of our discussions. Like any strong partnership, compromise did occur. Our respect for each other and our experiences allowed us to make decisions together in a respectful manner.

I discovered that when students were completing a task that they enjoyed they were more attentive and willing to participate. For example, when delivering instruction on the historical figures in Chemistry, the students paid close attention to the demonstrations of the experiments done by the historical figures. When Mr. Rockwell and I demonstrated Rutherford's Gold Foil experiment, the students were almost jumping out of their seats. After we conducted the experiment, many students volunteered answers when I questioned them about it. Although the students came to our classroom with interests of their own, Mr. Rockwell and I evoked interests in the students that weren't there before entering our classroom (Tomlinson, 2003).

WHERE TO GO FROM HERE

It is my goal for the years that follow to create more differentiated lessons. It was easiest for me to create differentiated lessons according to a student's learning profile. I would like to design more lessons that are geared toward student readiness. Tiering lessons is one way of accomplishing this task (Tomlinson, 2003). "Tiering is an instructional approach designed to have students of differing readiness levels work with essential knowledge, understanding, and skill, but to do so at levels of difficulty appropriately challenging for the individual" (Tomlinson, 2003).

Throughout the study, I learned to reflect-in-action. Rather than accepting the scores of the students on assessments and moving on to the next topic, I analyzed the assessments to see if there were any common mistakes or misconceptions. By doing this, I could work individually with the students to assist them with success in the classroom. I could also address the whole class if the students were having difficulty with a topic. I will continue to reflect- in-action in the classroom and when analyzing student work.

I have also become more interested in Howard Gardner's Multiple Intelligences. I would like to attend a professional development conference on the intelligences. From the knowledge gained at the conference and through my own research, I would like to develop lessons that incorporate a variety of intelligences. I would like to gain more knowledge about the intrapersonal and musical learners in the classroom.

I would also use multiple entry journals in the classroom (Tomlinson, 2003). Because Chemistry contains many concepts dealing with mathematics, I use the journal to teach the mathematical concepts. In the first column, the students will write down a basic mathematic problem. In the second column, they will solve the problem. In the third column, they will write out in words how they solved the problem. In the last column, the students will solve a Chemistry problem that incorporates the mathematical concept which was learned.

Since I am a special education teacher, I can move from one content area to another content area. If this occurs, I would like to research and create differentiated activities that would be useful in the next setting.

Overall, I will continue to find ways to make learning interesting and fun for my students. I would like to design lessons that not only increase academic achievement, but motivate students as well.

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APPENDIXES

Appendix A: HSIRB Approval

1 7 4 2

MORAVIAN COLLEGE

September 7, 2007

Rebecca M. Olah
[redacted]

Dear Rebecca M. Olah:

The Moravian College Human Subjects Internal Review Board has accepted your proposal: "Increasing student achievement and motivation by differentiating instruction in an inclusive high school Chemistry classroom." Given the materials submitted, your proposal received an expedited review. A copy of your proposal will remain with the HSIRB Chair.

Please note that if you intend on venturing into other topics than the ones indicated in your proposal, you must inform the HSIRB about what those topics will be.

Should any other aspect of your research change or extend past one year of the date of this letter, you must file those changes or extensions with the HSIRB before implementation.

This letter has been sent to you through U.S. Mail and e-mail. Please do not hesitate to contact me by telephone ([redacted]) or through e-mail ([redacted]@moravian.edu) should you have any questions about the committee's requests.

[redacted]
Chair, Human Subjects Internal Review Board
Moravian College
[redacted]

1200 MAIN STREET • BETHLEHEM, PENNSYLVANIA 18018-6650 • (610) 861-1300

Appendix B: Board of Education Approval

Dear [redacted],

I am currently working toward earning a Master's degree in Curriculum and Instruction at Moravian College. The courses that I am taking allow me to stay current with the most effective teaching methods in order to provide the best learning experience for students in Somerville High School. In order to earn my degree, I am required to conduct a systematic study of my own teaching practices for the MEDU 704 Action Research Thesis course.

During the fall semester (August 28th- December 21st), I plan to study the effects of incorporating differentiated instruction into specific units of instruction. For the study, I will be collecting data from student work, observed behaviors, and surveys. I am asking your permission to conduct this study at the high school in my CP Chemistry class for approximately eighteen weeks. There is no anticipated risk presented by this research. All children will follow the curriculum approved by the [redacted] Board of Education. Participation is entirely voluntary and will not affect the students' grades in any way. Any student may withdraw from this study at any time without penalty. All student names, faculty members, and the school name will be kept confidential by using pseudonyms in all written reports. All research material will be secured in a protected location and later destroyed by shredding.

If you would like to meet with me to discuss this study, please contact me by phone [redacted] or email at [redacted]. [redacted]; [redacted] for [redacted] can also be contacted at [redacted] or by email at [redacted]. My faculty sponsor is [redacted] who can be contacted at Moravian College ([redacted]) or by email at [redacted]. Thank you for your time and cooperation.

Sincerely,

Rebecca Olah

Special Education Teacher

[redacted]

Please check the appropriate box below and sign the form:

- ☐ I give permission for my school to participate in this project. I understand that I will receive a signed copy of this form. I have read this form and understand it.
- ☐ I do not give permission for my school to participate in this project.

Signature of Superintendent______________________Date:_________________

Appendix C: Parental Consent Form

Dear Parent,

I am currently working toward earning a Master's degree in Curriculum and Instruction at Moravian College. The courses that I am taking allow me to stay current with the most effective teaching methods in order to provide the best learning experience for your child. In order to earn my degree, I am required to conduct a systematic study of my own teaching practices.

This semester (August 28 – December 21, 2007) I plan to study the effects of incorporating differentiated instruction into specific units of instruction. The study will take place in your child's CP Chemistry class and will last for 18 weeks. There is no anticipated risk presented by this research. All children will follow the curriculum approved by the [redacted]. For the study, I will be collecting data from student work, observed behaviors, surveys, and interviews. I am asking your permission to use this data gathered pertaining to your child's involvement in classroom activities. Participation is entirely voluntary and will not affect your child's grade in any way. Your child may withdraw from this study at any time without penalty. All student names, faculty members, and the school name will be kept confidential by using pseudonyms in all written reports. All research material will be secured in a protected location and later destroyed by shredding.

If you have any questions about my research please contact me by note, phone ([redacted]), or email at [redacted]. [redacted] can also be contacted ([redacted]) or by email at [redacted]. My faculty sponsor is [redacted] who can be contacted at Moravian College ([redacted]) or by email at [redacted]. Please sign below and return the consent form as soon as possible. Thank you for your time and cooperation.

Sincerely,

Rebecca Olah

Special Education Teacher

Please check the appropriate box below and sign the form:

- ☐ I give permission for my child's data to be used in this study. I understand that I will receive a signed copy of this consent form. I have read this form and understand it.
- ☐ I do not give permission for my child's data to be included in this project.

Parent/guardian signature ____

Child's name____

Date: ____

Appendix D: Multiple Intelligence Survey

Multiple Intelligence Survey

Part I : Complete each section by placing a “1” next to each statement you feel accurately describes you. If you do not identify with a statement, leave the space provided blank. Then total the column in each section.

Section 1

_____ I enjoy categorizing things by common traits
_____ Ecological issues are important to me
_____ Classification helps me make sense of new data
_____ I enjoy working in a garden
_____ I believe preserving our National Parks is important
_____ Putting things in hierarchies makes sense to me
_____ Animals are important in my life
_____ My home has a recycling system in place
_____ I enjoy studying biology, botany and/or zoology
_____ I pick up on subtle differences in meaning

_____ TOTAL for Section 1

Section 2

_____ I easily pick up on patterns
_____ I focus in on noise and sounds
_____ Moving to a beat is easy for me
_____ I enjoy making music
_____ I respond to the cadence of poetry
_____ I remember things by putting them in a rhyme
_____ Concentration is difficult for me if there is background noise
_____ Listening to sounds in nature can be very relaxing
_____ Musicals are more engaging to me than dramatic plays
_____ Remembering song lyrics is easy for me

_____ TOTAL for Section 2

Section 3

_____ I am known for being neat and orderly
_____ Step-by-step directions are a big help
_____ Problem solving comes easily to me
_____ I get easily frustrated with disorganized people
_____ I can complete calculations quickly in my head
_____ Logic puzzles are fun
_____ I can't begin an assignment until I have all my "ducks in a row"

_____ Structure is a good thing
_____ I enjoy troubleshooting something that isn't working properly
_____ Things have to make sense to me or I am dissatisfied

_____ TOTAL for Section 3

Section 4

_____ It is important to see my role in the "big picture" of things
_____ I enjoy discussing questions about life
_____ Religion is important to me
_____ I enjoy viewing art work
_____ Relaxation and meditation exercises are rewarding to me
_____ I like traveling to visit inspiring places
_____ I enjoy reading philosophers
_____ Learning new things is easier when I see their real world application
_____ I wonder if there are other forms of intelligent life in the universe
_____ It is important for me to feel connected to people, ideas and beliefs

_____ TOTAL for Section 4

Section 5

_____ I learn best interacting with others
_____ I enjoy informal chat and serious discussion
_____ The more the merrier
_____ I often serve as a leader among peers and colleagues
_____ I value relationships more than ideas or accomplishments
_____ Study groups are very productive for me
_____ I am a "team player"
_____ Friends are important to me
_____ I belong to more than three clubs or organizations
_____ I dislike working alone

_____ TOTAL for Section 5

Section 6

_____ I learn by doing
_____ I enjoy making things with my hands
_____ Sports are a part of my life
_____ I use gestures and non-verbal cues when I communicate
_____ Demonstrating is better than explaining
_____ I love to dance
_____ I like working with tools
_____ Inactivity can make me more tired than being very busy
_____ Hands-on activities are fun
_____ I live an active lifestyle

_____ TOTAL for Section 6

Section 7

_____ Foreign languages interest me
_____ I enjoy reading books, magazines and web sites
_____ I keep a journal
_____ Word puzzles like crosswords or jumbles are enjoyable
_____ Taking notes helps me remember and understand
_____ I faithfully contact friends through letters and/or e-mail
_____ It is easy for me to explain my ideas to others
_____ I write for pleasure
_____ Puns, anagrams and spoonerisms are fun
_____ I enjoy public speaking and participating in debates

_____ TOTAL for Section 7

Section 8

_____ My attitude effects how I learn
_____ I like to be involved in causes that help others
_____ I am keenly aware of my moral beliefs
_____ I learn best when I have an emotional attachment to the subject
_____ Fairness is important to me
_____ Social justice issues interest me
_____ Working alone can be just as productive as working in a group
_____ I need to know why I should do something before I agree to do it
_____ When I believe in something I give more effort towards it
_____ I am willing to protest or sign a petition to right a wrong

_____ TOTAL for Section 8

Section 9

_____ Rearranging a room and redecorating are fun for me
_____ I enjoy creating my own works of art
_____ I remember better using graphic organizers
_____ I enjoy all kinds of entertainment media
_____ Charts, graphs and tables help me interpret data
_____ A music video can make me more interested in a song
_____ I can recall things as mental pictures
_____ I am good at reading maps and blueprints
_____ Three dimensional puzzles are fun
_____ I can visualize ideas in my mind

_____ TOTAL for Section 9

Part II

Appendix E: Student Interest Survey

Interest Survey

Student Interest Survey

ABOUT YOU!

Name:

Directions: Please help me know you better so I can teach you better. Give as much information as you can.

1. What are your favorite things to do outside of school? (Please tell why you like them.)

2. When you have you felt proud of yourself? Please explain why you felt that way.

3. What are you good at in school? How do you know?

4. What's hard for you in school? What makes it hard?

5. What are some ways of learning that work for you?

6. What are some ways of learning that do not work well for you? Why?

7. What's your favorite:

Book____

TV show____

Movie____

Kind of music____

Sport____

Adapted from Tomlinson, C. A. (2003). Fulfilling the promise of the differentiated classroom. Alexandria, VA: Association for Supervision and Curriculum Development.

8. What mathematics class did you take last year? Who was your teacher?

9. What mathematics class are you taking this year? Who is your teacher?

10. Do you want to go to college?

11. What else should I know about you as a person and a student that could help me teach you better?

12. Describe how you see yourself as an adult. What will you be doing? Enjoying? Working towards?

Adapted from Tomlinson, C. A. (2003). Fulfilling the promise of the differentiated classroom. Alexandria, VA: Association for Supervision and Curriculum Development.

Appendix F: Cooperative Grouping Survey

1. I would have liked it if the teacher taught the whole class.

I agree I partially agree I hardly agree I disagree

2. The teacher did not help us enough.

I agree I partially agree I hardly agree I disagree

3. I have learned a lot by working in the group.

I agree I partially agree I hardly agree I disagree

4. I did not like working in a cooperative group because I had to do too much work for my group.

I agree I partially agree I hardly agree I disagree

5. I was confused when working in the group.

I agree I partially agree I hardly agree I disagree

6. I like working in the cooperative group because I could work with many different people.

I agree I partially agree I hardly agree I disagree

7. I had a hard time organizing my work when working in the group.

I agree I partially agree I hardly agree I disagree

8. Using different teaching methods makes our lessons fun and less boring.

I agree I partially agree I hardly agree I disagree

9. I like to work in a cooperative classroom again.

I agree I partially agree I hardly agree I disagree

Adapted from survey used in Eilks, I. (2005). Experiences and reflections about teaching atomic structure in a jigsaw classroom in lower secondary school chemistry lessons. *Journal of Chemical Education, 82*(2), 313-319.

Appendix G: Proposed Interview Questions

1. I would have liked it if the teacher taught the whole class.

I agree I partially agree I hardly agree I disagree

2. The teacher did not help us enough.

I agree I partially agree I hardly agree I disagree

3. I have learned a lot by working and researching with a partner.

I agree I partially agree I hardly agree I disagree

4. I did not like working in pairs because I had to do too much work for my group.

I agree I partially agree I hardly agree I disagree

5. I did not like working with the whole class because I had to do too much work for my group.

I agree I partially agree I hardly agree I disagree

6. I liked the timeline activity because I could work with many different people.

I agree I partially agree I hardly agree I disagree

7. I had a hard time organizing my work when working in pairs.

I agree I partially agree I hardly agree I disagree

8. I had a hard time organizing my work when creating the timeline with the whole class.

I agree I partially agree I hardly agree I disagree

9. Using different teaching methods makes our lessons fun and less boring.

I agree I partially agree I hardly agree I disagree

Adapted from survey used in Eilks, I. (2005). Experiences and reflections about teaching atomic structure in a jigsaw classroom in lower secondary school chemistry lessons. *Journal of Chemical Education, 82*(2), 313-319.

Appendix H: Rubric lab poster/Powerpoint

CATEGORY	4	3	2	1
Graphics – Relevance	All graphics are related to the topic and make it easier to understand. All borrowed graphics have a source citation.	All graphics are related to the topic and most make it easier to understand. All borrowed graphics have a source citation.	All graphics relate to the topic. Most borrowed graphics have a source citation.	Graphics do not relate to the topic OR several borrowed graphics do not have a source citation.
Graphics - Clarity	Graphics are all in focus and the content easily viewed and identified from 6 ft. away.	Most graphics are in focus and the content easily viewed and identified from 6 ft. away.	Most graphics are in focus and the content is easily viewed and identified from 4 ft. away.	Many graphics are not clear or are too small.
Attractiveness	The poster is exceptionally attractive in terms of design, layout, and neatness.	The poster is attractive in terms of design, layout and neatness.	The poster is acceptably attractive though it may be a bit messy.	The poster is distractingly messy or very poorly designed. It is not attractive.
Mechanics	Capitalization and punctuation are correct throughout the poster.	There is 1 error in capitalization or punctuation.	There are 2 errors in capitalization or punctuation.	There are more than 2 errors in capitalization or punctuation.

Date Created: **Apr 09, 2007**
08:39 am (CDT)

CATEGORY	4	3	2	1
Background	Background does not detract from text or other graphics. Choice of background is consistent from card to card and is appropriate for the topic.	Background does not detract from text or other graphics. Choice of background is consistent from card to card.	Background does not detract from text or other graphics.	Background makes it difficult to see text or competes with other graphics on the page.
Graphics Sources	Graphics are hand-drawn. The illustrator(s) are given credit somewhere in the presentation.	A combination of hand-drawn and HyperStudio graphics are used. Sources are documented in the presentation for all images.	Some graphics are from sources that clearly state that non-commercial use is allowed without written permission. Sources are documented in the presentation for all "borrowed" images.	Some graphics are borrowed from sites that do not have copyright statements or do not state that non-commercial use is allowed, OR sources are not documented for all images.
Content - Accuracy	All content throughout the presentation is accurate. There are no factual errors.	Most of the content is accurate but there is one piece of information that might be inaccurate.	The content is generally accurate, but one piece of information is clearly flawed or inaccurate.	Content is typically confusing or contains more than one factual error.
Sequencing of Information	Information is organized in a clear, logical way. It is easy to anticipate the type of material that might be on the next card.	Most information is organized in a clear, logical way. One card or item of information seems out of place.	Some information is logically sequenced. An occasional card or item of information seems out of place.	There is no clear plan for the organization of information.

Date Created: **Apr 09, 2007 08:42 am (CDT)**

Appendix I: Review Survey

1. Did the use reviewing with Jeopardy help you retain more information about the Chemistry topic? Why or why not?

2. Was the use of Jeopardy review useful to you before assessments? Why or why not?

3. Did the use of Jeopardy organize the information for you? Why or why not?

4. Would you like to use Jeopardy for another review?

5. What other ways would you like to review for tests?

6. Other suggestion?

Appendix J: Timeline Survey

1. I would have liked it if the teacher taught the whole class.

I agree I partially agree I hardly agree I disagree

2. The teacher did not help us enough.

I agree I partially agree I hardly agree I disagree

3. I have learned a lot by working and researching with a partner.

I agree I partially agree I hardly agree I disagree

4. I did not like working in pairs because I had to do too much work for my group.

I agree I partially agree I hardly agree I disagree

5. I liked the timeline activity because I could work with many different people.

I agree I partially agree I hardly agree I disagree

6. Using different teaching methods makes our lessons fun and less boring.

I agree I partially agree I hardly agree I disagree

Adapted from survey used in Eilks, I. (2005). Experiences and reflections about teaching atomic structure in a jigsaw classroom in lower secondary school chemistry lessons. *Journal of Chemical Education, 82*(2), 313-319.

Appendix K: Periodic Table Activity

Choose one of the following:

Verbal/ linguistic- in your own words, describe the historical development and the current organization of the elements found on the periodic table.

Logical/mathematical- Brainstorm a list of properties other than mass, that could be used to organize the elements of the periodic table. Use one of these properties to construct a new version of the existing periodic table.

Visual/spatial- Copy each square of the existing periodic table on a 3" x 5" file card. Classify these cards in some meaningful way and write a paragraph explaining the rationale for your classification system.

Musical/Rhythmic- Develop a rhythmic pattern to represent any ten elements of the periodic table. Teach your pattern of sounds to some peers and have them use it to represent the other elements of the periodic table.

Interpersonal- Work with other members of the class to create a king sized version of the periodic table for the bulletin board. Ask each student to select tow elements from the periodic table and to use a square piece of paper to record the following information for each of the elements: symbol of the element, atomic mass, atomic number, and three interesting facts about the elements itself.

Intrapersonal- Express your personal opinion of the current organization of the periodic table. Does it make sense to you? Or would you have organized it differently had you been directing its development?

Hudson, D. (2006). Differentiated instruction for science: Instructions and activities for the diverse classroom. Portland, ME: Walch Publishing.