

DIFFERENTIATING INSTRUCTION WITH REGARD TO GENDER AND
LEARNING STYLE IN A BIOLOGY CLASS

by

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ABSTRACT

In this investigation, daily lessons, assignments, labs, lectures, and assessments were differentiated with regard to both gender and learning style preference to determine the effect on student in-class performance and classroom dynamics. Males and females were shown to prefer different learning modalities and in-class performance varied with the differentiation technique employed. Students who showed an equal preference for more than one learning style consistently outperformed their peers who only preferred one modality. Additionally, a subpopulation of students was identified based on their learning style preferences. Interestingly, these kinesthetic learners skewed the data and a kinesthetic trend was noted. Kinesthetic male learners on individualized education plans (IEPs) were also found to be underserved in the traditional classroom. Female intrapersonal learners and male kinesthetic learners were found to be at odds throughout the study. Overall, this investigation revealed little difference between the genders with regard to classroom dynamics and class appeal. In general, classroom dynamics and class appeal were improved as a result of the differentiation.

INTRODUCTION AND BACKGROUND

Personal Experience

Gender differences in learning style have always been of great personal interest. This interest stems primarily from several experiences in high school and college. Beginning in seventh grade, my class was tracked with regard to our English and math abilities. I was placed in both accelerated English and math along with my peers. The English class contained roughly equal numbers of males and females, about ten of each. This balance continued until we graduated; total class size decreased to twelve but the distribution of males and females remained evenly divided. The math class was another story. In seventh grade, the class consisted of approximately 20 students split roughly 60% male and 40% female. By the time we graduated the total class size had decreased to seven students: six males and one female—me. Because of the schedule, most of the advanced English and math students ended up in the same section of other classes. In general the science elective classes were male dominated, while the social studies classes were evenly divided between the genders. In fact during my senior year, I had two classes, calculus and physics, in which I was in a very small minority. A male taught physics and a female taught calculus, both of these instructors were teaching their respective subject for the first time in several years. My experience in these classes was vastly different. Calculus was a breeze and I understood everything as it was taught, I think I was one of three people who could understand the teacher as she was teaching. After she was done teaching for the day, she would let us work as a group to finish the assignment. During this group time, the three of us who understood her teaching style

would have to reteach the material to the rest of the class in a slightly different manner so that they could understand the lesson. Physics was almost the exact opposite. I learned primarily from my peers. Somewhere during the course of the year, I began to reflect on the role gender played in learning and teaching style. In college there were a few classes where I was again overwhelmingly in the minority. Each experience was different, but I think that gender was a large factor in these experiences.

Teacher Experience

Once I graduated and began my teaching career, I noticed some differences between classes but none of those differences were as vast as the ones experienced during the 2009-2010 school year. That year I had several classes that were skewed in the distribution of males and females: seventh period 7th grade life science (eight males, two females, and a senior male TA), fifth period general biology (nine sophomore males), third period advanced biology (eleven junior females, and one senior female), and special topics biology (four senior males). The instructional strategies employed in each of these gender homogenous classes varied greatly, but students in these classes consistently had higher grades than their peers in other sections. On average, the students in gender homogenous classes had grades which were approximately one full letter grade higher than their peers. These classes were also easier to manage and had fewer discipline issues than the other sections. Overall, the 2009-2010 school year was very interesting and enjoyable. It gave me much fodder for reflection and provided an ideal environment in which to test ideas and plan an experiment based on the varied instructional strategies I had learned.

During the school year of 2010-2011, I conducted a research project based on differentiating instruction with regard to gender and learning style. Lessons learned and plans made during 2009-2010 were implemented during 2010-2011 and data were collected. This paper is the result of that effort and focuses on applying differentiated teaching strategies in a mixed classroom to accommodate both males and females. The primary question considered during the course of this investigation was: What impact does instruction, differentiated with respect to learning style and gender, have on student performance and classroom dynamics? Secondary questions considered include the following four questions.

- 1) How do different teaching and assessment strategies affect overall appeal of the class and classroom dynamics?
- 2) How does the implementation of differentiated teaching and assessment strategies affect classroom management and dynamics?
- 3) What is the measurable relationship between gender and learning style modality (kinesthetic, auditory, visual, interpersonal, and intrapersonal)?
- 4) What are the impacts on the teacher?

This investigation has proven to be interesting and would not have been possible without the help, support, and input of several people. Madeleine Pitsch is a school psychologist in Rocksprings, Wyoming. She has an Ed.S. and is very interested in gender differences and brain development. Consequently, she has been of great help in developing classroom activities and providing background information. Rose Lundby-Powell is the principal directly in charge of this investigation. She has been instrumental in providing logistical support and acting as a sounding board. Craig Earley is the final

member of the support team. He is a former student and provides vital feedback with the unique perspective necessary to keep the research grounded.

CONCEPTUAL FRAMEWORK

Differences Between Males and Females

Physical Differences

Males and females are fundamentally different. These variances have a biological basis and affect all aspects of life, including learning. Vision is one area where females and males are different. Due to the difference in distribution of rods and cones in the eye, male eyes are generally more sensitive to motion whereas female eyes are more sensitive to color differentiation (Sax, 2005). Females are also more sensitive to sound than males (Sax, 2005). Vision and hearing are not the only places where males and females differ. Male and female brains vary in their myelination, structure, function, and chemistry (Menzler et.al., 2010; Cosgrove, Mazure, & Staley, 2007). Menzler et. al. (2010), found that adult male and female brains differ in their microstructure and suggest that “the origin of the observed sex differences of brain structure as well as their possible behavioral correlates. . .warrant future studies” (p.2559). “[B]rain volume is greater in men than women [and]. . .women have a higher percentage of gray matter and men a higher percentage of white matter. Global cerebral blood flow is higher in women than in men. Sex-specific differences. . .indicate that male and female brains are neurochemically distinct” (Cosgrove, Mazure, & Staley, 2007, p. 847). Some of these brain differences can be seen during puberty and in females are linked to sex hormones. Peper et. al.

(2009), found that “in pubertal girls, estradiol may be implicated in neuronal changes in the cerebral cortex during this important period of brain development” (p. 333).

Gender based differences in vision, hearing, and brain structure should be important to classroom educators because these factors affect how students perceive and process information about the world. If teachers can better understand the biological variance between the genders then they can be better prepared to anticipate and accommodate their students’ needs. For example if males are less sensitive to sound, then they may benefit from being closer to the teacher during direct instruction (Sax, 2005).

Processing Differences

Recent research suggests males and females process visual information differently (Cadieux, Barenett-Cowan, & Shore, 2010). In this study, researchers asked undergraduate participants (48 adults, 24 female) to respond to vibrations felt in their hands by lifting their corresponding foot off of a pedal; participants accomplished this task during one trial with their hands crossed and during the other trial with their hands uncrossed (Cadieux, Barenett-Cowan, & Shore, 2010). During both trials, participants had their eyes open and were allowed to look at their hands as they responded to the vibrations (Cadieux, Barenett-Cowan, & Shore, 2010). Then participants were asked to participate in a rod-and-frame test (Cadieux, Barenett-Cowan, & Shore, 2010). The researchers found that females were more visually dependent and were also more likely to use “different processes for vestibular-visual transformations and for visuohaptic transformations” (Cadieux, Barenett-Cowan, & Shore, 2010, p. 443), whereas males were more likely to employ “a single process for translating between reference frames”

(Cadieux, Barenett-Cowan, & Shore, 2010, p. 443). Additional research conducted on individuals with visual impairment (adults age 20-65) found that the two greatest factors, which affected balance, were amount of vision loss and gender (Ray & Wolf, 2010). Females with low vision had the least postural stability (Ray & Wolf, 2010).

These two studies seem to suggest that females process visual information differently than males. This fact could have implications in math and science classes where students are asked to visually compare and manipulate variables. The old stereotype that boys are better at visualizing and manipulating shapes in their head may not be totally wrong. Teachers should be aware of these processing differences so that they can differentiate lessons to accommodate learners who process visual information differently. For example female students may benefit from building a model and then manipulating it on their desks so that they can better understand how it looks as it moves through space.

Auditory processing also appears to be different in males and females. Undergraduate university students (50 total, 25 female) were asked to listen to virtual, approaching, looming sounds and determine the sounds distance, then they were asked to determine the distance of receding sounds (Neuhoff, Planisek, & Seifritz, 2009). The researchers found that both females and males consistently underestimated the “time-to-arrival” of the looming sounds, and that females were significantly less accurate than males (Neuhoff, Planisek, & Seifritz, 2009). However there were no differences between the genders during the receding noise trials (Neuhoff, Planisek, & Seifritz, 2009). According to the researchers, there is a possible evolutionary explanation for the results of this study. Females who more sensitive to looming sounds and underestimated the

distance between the source and themselves may have had more reaction time and were therefore better equipped to respond to the stimuli (Neuhoff, Planisek, & Seifritz, 2009).

Differences in the way sound is processed could affect learning in a classroom, especially one that is noisy or where students are required to differentiate between a wide varieties of sound cues. A fundamental understanding of the differences between the genders can lead to improved teaching techniques. For example, a male student who is tapping his pencil on his desk is unaware of the noise, while the female student sitting next to him is being distracted because the noise is too loud (Sax, 2005). If the teacher tells the boy to be quiet s/he has taken the boy off task and impeded one of his tactile stimuli, which in turn has hindered his learning. If the teacher allows the noise to continue, the female student will continue to be distracted and her education may suffer. Regardless of the teacher's actions, one student's learning is impeded, unless the teacher is aware of the biological differences. In that case, the teacher could suggest a third alternative, like having the boy tap his pencil on a mouse pad instead of on the desk. This solution keeps the boy in motion, helping him learn, and quiets the noise, helping the girls learn as well. If teachers are aware of these basic biological differences, they can find options that help both genders in the classroom.

Processing differences are not limited to handling sensory input. Keller & Menon (2009), found that “[a]lthough females and males did not differ in accuracy or response times. . .significant gender differences in functional brain activation were observed in the right dorsal and ventral visuospatial information processing streams” (p. 342). These researchers asked university students (49 total, 25 female) to perform math calculations and identify numbers while in an fMRI (Keller & Menon, 2009). The fMRIs revealed

that “[g]ender differences were all localized to the right posterior regions of the brain, where number and space interact” (Keller & Menon, 2009, p. 348). Although there were differences between the brains of male and female participants, there were no behavioral differences observed, but the participants in this research were comparatively intelligent, educated people performing basic math calculations (Keller & Menon, 2009). They did however state that children performing these tasks might express “differences in visualization of multiple solution paths. . .during math cognition tasks” (Keller & Menon, 2009, p. 351).

If these researchers are correct and males and females do process math differently, then many classroom teachers may need to revise and alter their teaching strategies so that all students can benefit from diverse instruction. Especially teachers engaged in introducing concepts for the first time, or teaching foundational material. It is key that students understand these basic concepts so that they can later build on this knowledge. If male and female processing is different and results in diverse understandings of the same concept then students may have a more challenging time in later classes, which build upon this foundational material.

Learning Styles and Gender

Alumran (2008), in a study of Bahraini university students, found that “there were significant differences in learning style according to gender and different fields of study...[and] the learning styles that were good predictors of student GPA were Visual/Verbal and Sequential/Global” (p. 303). “[I]nstructors may have to make conscious and serious efforts to encourage females by relating what they learn to their lives and by using concrete examples and focusing on details, while providing males with

ample opportunities for problem solving, reflections, imagination, while avoiding routine repetitive work” (Alumran, 2008, p. 311). Interestingly, Sax (2005) provides a biological explanation for this gender based difference; males tend to process spatial relations (key to understanding math, especially geometry) in the hippocampus, whereas females process this information in the cerebral cortex. The cerebral cortex is “the same division of the brain that mediates language and higher cognitive functions” (Sax, 2005, p. 104). Therefore, females need to form connections in their brains to support their understanding. The easiest way for females to form these connections is to see the math applied to the real world.

For example, when introducing Φ and the Fibonacci sequence in a math class, a teacher needs to use two different approaches; one for males and one for females (Sax, 2005). Sax (2005) suggests that when introducing the sequence to boys, it is more beneficial to appeal to their innate interest in math by challenging the boys to find patterns within the sequence itself whereas, when introducing the same concept to girls, it is more beneficial to make the math more applicable to a real-life scenario. One way to ground this sequence in reality is by having the girls count the number of petals on daisies, the number of rows on artichokes or sunflowers, or measure the spiral of a nebula (Sax, 2005). All of these examples will lead the girls back to numbers on the Fibonacci sequence or Φ .

Orhun (2007), in a study of Turkish university students, found “that there were differences among learning modes preferred by female and male students, their mathematical achievements, and their attitudes towards mathematics” (p. 321). These findings support the concept that matching learning styles with teaching styles results in

higher student performance. Learning styles also have a strong correlation to gender differences. Males in the study tended to prefer the Assimilator learning style; these individuals learned “best from lectures and demonstrations” (Orhun, 2007, p. 327). Females in the study were found to learn best using the Converger learning style; these individuals prefer to “make decisions and solve problems objectively using factual data” (Orhun, 2007, p. 327). Despite the preference of different learning styles, there was no gender-based performance gap found in this study (Orhun, 2007). I suspect that Orhun (2007) did not find a gender-based performance gap because the subjects in this study were comparatively intelligent, educated individuals with a preference toward mathematics much like the students in the Keller & Menon (2009) study. Both of these studies used a subpopulation, which does not reflect the total distribution of the general population. University students are presumably more intelligent and educated than the general population.

In my opinion, the most important aspect of the Orhun (2007) article was the statement that teaching methods need to match learning styles. This statement is again supported by Sax (2005). In his book, he discussed the stereotype that males do not like to read fiction and perform poorly in English. One of the reasons for this stereotype is the fact that English classes often call upon students to describe how they feel, imagine if they were the central character, or solicit some other emotional reaction (Sax, 2005). For females, feelings are processed in the cerebral cortex, the same area that processes language (Sax, 2005). Consequently, females can express their feelings in language easily (Sax, 2005). Males process their emotions in their amygdala, an area of the brain far from their language centers in the cerebral cortex (Sax, 2005) and consequently have

difficulty expressing emotion, because the connections between these areas are not well developed (Sax, 2005). Now, consider an English class that matches male learning to teaching style. Rather than asking males to discuss their feelings about the central setting and mood of the book perhaps they could make a model of the central settings that conveys the mood (Sax, 2005). Males in this English class have to read the book carefully and critically to have a complete understanding of the setting and they can use one of their preferred learning styles to demonstrate an understanding of the book (Sax, 2005). If all teachers could match their teaching style to their students' learning styles, imagine how much more engaging the high school curriculum could be and how much more productive students would be.

Honigsfeld and Dunn (2003), in a study of more than 1,600 adolescents from around the world, found that “male students. . .tended to prefer more peer interaction rather than learning alone and more kinesthetic activities. On the other hand, female students on average needed higher temperatures and more social variety of learning, and they were more self-motivated, parent motivated, and teacher motivated; more persistent; and more responsible or conforming” (Honigsfeld & Dunn, 2003, Results section, para 2). Interestingly, these researchers went on to say that “although girls' and boys' learning styles differ from each other in many ways, individuals within each group are even more unique than either group as a whole” (Honigsfeld & Dunn, 2003, Unanticipated Findings and Their Implications section, para 2). Finally these researchers went on to conclude that teachers should be aware of the differences and “enhance students' educational experiences and academic achievement in a culturally appropriate way by identifying,

understanding, and responding to the unique learning styles of students” (Honigsfeld & Dunn, 2003, Unanticipated Findings and Their Implications section, para 7).

Slater, Lujan, and DiCarlo’s (2007) article indicated that females tend to prefer a wide variety of learning modalities and that males tended to use tactile resources. This study also found that males prefer to learn alone and that females prefer to learn with others, in groups, pairs, etc. (Slater, Lujan, & DiCarlo, 2007). The researchers also stated that the faculty in medical schools is predominately male and these teachers need to be cognizant of their diverse students’ needs (Slater, Lujan, & DiCarlo, 2007). Instructors need to use a wide range of techniques to ensure that they are not teaching to one subset of students while ignoring the instructional needs of another subset (Slater, Lujan, & DiCarlo, 2007).

Teachers at all levels of education need to be cognizant of how their personal attributes may be affecting the learning of their students. Most elementary teachers tend to be female and due to the inherent gender differences in vision and hearing perceive the world vary differently than the male student in their classes (Sax, 2005). Consequently, a young male student may dislike the quiet classroom preferred by the teacher; eventually viewing school as boring and no fun, because he cannot interact with his environment, as he would like based on his gender-influenced perception of the world.

Conflicting Research and Emerging Data

The conflict in data is most evident in the emerging brain research. Sax (2005) and Keller & Menon (2009) disagree vastly in their conclusions about which areas of the brain control which functions. Most of the research in this area is rapidly emerging and

changes frequently as technology increases. Educators need to stay informed as the neuroscience emerges so that they can better accommodate their diverse learners' needs.

Additionally, Orhun (2007) and Alumran (2008) seem to disagree in their conclusions about gender-based learning style preferences. Alumran (2008) states that males need exposure to problem solving, an opportunity to reflect, a chance to use their imagination and be innovative, and to avoid repetitive work. Orhun (2007) states that males learn best when they are taught using lectures and demonstrations. There may be a cultural explanation for some of these differences because Alumran (2008) used Bahraini students while Orhun (2007) used Turkish students. Despite the difference in male results, both Orhun (2007) and Alumran (2008) found that females benefited from the use of concrete examples and factual data. Both of these studies were focused on university-aged students.

Honigsfeld and Dunn (2003) and Slater, Lujan, and DiCarlo's (2007) disagree on the point that males tend to prefer learning in groups. Honigsfeld and Dunn (2003) found that males preferred groups where as Slater, Lujan, and DiCarlo's (2007) did not. One reason for the difference in findings may have been the fact that Honigsfeld and Dunn (2003) were using secondary students where as Slater, Lujan, and DiCarlo's (2007) were using post-secondary students. More research needs to be done in this area in order to paint a more accurate picture of student learning.

Differentiation and Learning Styles

Al-Balhan (2006) found that (Kuwaiti) middle school students enrolled in an after school reading tutoring program preformed better, when they were tutored using differentiated techniques based on Gardner's learning styles, than a similar group of

students who received tutoring using traditional teaching techniques. The treatment group ended up with better overall grades in reading than did the control group (Al-Balhan, 2006). “This study demonstrated that knowledge of a student's type of intelligence and appropriate teaching methods improve overall reading performance”(Al-Balhan, 2006, Conclusions section, para 2) and concluded that it benefits students when teachers adjust their teaching style to accommodate learners’ needs and are aware of their own personal learning/teaching style preferences.

The Al-Balhan (2006) study of reading grades was followed a year later by Al-Balhan (2007) which looked at the same general population’s grades in math. Again the researcher found that the experimental group who had received tutoring using instruction differentiated with regard to learning style preformed better in their math scores (Al-Balhan, 2007). The only difference between the two studies was that in the 2006 study, females living in suburban areas attending private schools showed the most improvement whereas urban males attending private schools preformed the best in the 2007 math study.

Interestingly, differentiation seems to be effective for both lower-achieving students and gifted students, but it must be continually assessed and targeted toward individual students. According to Adams (2010) “[t]rue differentiation involves constantly assessing students and tailoring instruction accordingly. You engage students with different learning modalities and varied rates of instruction and complexity. It's a student-centered classroom, in which you respond to where kids are and provide choices and flexibility” (Adams, 2010, p. 31). There are four basic ways to differentiate instruction: 1) by readiness; 2) by interest; 3) by process; and 4) by product (Adams,

2010). Using these techniques both gifted and remedial students can be served in the same classroom.

Impacts on the School and Greater Community

Hertberg-Davis and Brighton (2006) concluded that “[t]eachers [tend] to take their cues about how to respond to differentiation from their principals. Principals who communicated passion for differentiation [tend] to have faculties who responded positively to the initiative and who made visible changes to their teaching practices that were [consistent] with differentiation” (Hertberg-Davis & Brighton, 2006, Recommendations for policy section, para. 1). It is key to have support from the administration and within a staff to increase the differentiation in a school. The idea of support is vital, especially when one considers the fact that many students can benefit from teachers who are willing to adjust the curriculum to student needs. This is of special importance in small rural schools where the principal must work closely with all staff members and where budgets must be considered with regard to staffing. It is key to serve the individuals on individualized education plans (IEPs) as well as the gifted and talented (GT) students.

Sylwester (2007) presented an interesting section on the implications of our changing society. He argues that students in the 21st century will need a different skill set than those of the 20th century. In the future, it will be paramount for students to be able to 1) discern the credibility of electronic sources; 2) relate to problems on the local and global level; 3) understand and apply increasingly complex technology as the line between biotechnology, computer technology, and electronic technology disappears; and 4) adapt to a changing workplace where a large percentage of the future jobs have not

even been invented (Sylwester, 2007). All of these 21st century skills need to be taught in our current classrooms. One way to accomplish this task is through the use of differentiation and education targeted toward specific stages of brain development, biologically based differences, and learning styles.

After reviewing the literature it is clear that differentiation with regard to gender and learning style is an area where more research is needed, especially in high school science classrooms; therefore this research project was conducted. It added to the body of research done this area and gave the researcher insight into the operation of her differentiated class.

METHODOLOGY

The research methodology for this project received an exemption by Montana State University's Institutional Review Board, and compliance for working with human subjects was maintained. It should also be noted that the teacher of this class is an auditory, intrapersonal female learner and feels most comfortable in a calm, quiet classroom.

Sample

For this research project the general biology students at Powder River County District High School, in Broadus, MT, were chosen as the sample. These classes were selected because they are required and the sample size would be as large and diverse as possible; the other biology classes offered are electives and would only represent the students with an interest in or inclination toward science. General biology is the last

required course for students and it is offered to students who have at least sophomore standing. These students have typically taken life science in seventh grade, physical science in eighth grade, and earth science as freshmen. General biology, along with earth science, is also a prerequisite class for all of the upper level science electives offered which include: chemistry, physics, advanced biology, and special topics biology.

The sample consisted of sophomores (29 students) and juniors (3 students repeating the class); of the 32 total students, 12 were female and 20 were male. Twelve were free/reduced lunch qualified students and 10 were IEP/title qualified students. There were only two minority students in the class (both Hispanic); the vast majority of the students were white, middle class students from stable two parent households. This school is rural and isolated; over 50% of the student population is bussed in daily and the average commute is 30 miles one-way.

Treatment

Non-treatment Unit

For the purposes of this research project, students were subjected to two different treatment routines. The first routine was traditional teaching during the first quarter and was the non-treatment portion of the class. This conventional unit consisted of taking notes while listening to lectures, completing questions from the book, completing supplemental worksheets, drawing diagrams and cartoons, completing laboratory exercises, writing article reports, and other traditional assignments. Material covered during this non-treatment unit included lab safety, the general themes of biology and other introductory material, as well as basic chemistry concepts such as pH. At the end of the quarter, students were given an online survey that asked their opinions of the class,

class dynamics, overall appeal of the class, and their feelings toward differentiation. This survey was administered so that baseline data could be determined. Post-treatment data were compared to this baseline to determine the changes in student attitudes.

Students were given the online Birmingham Grid for Learning (BGfL) Multiple Intelligences (Secondary) hosted online (Appendix A) on the second day of school. The BGfL was again administered near the end to the non-treatment unit to insure that student learning styles has not changed dramatically during the first quarter. The preferred learning styles of the students were examined and the treatment units were developed with the students' needs in mind; these treatments units were administered during the second routine during the entire second quarter and part of the third quarter.

Kinesthetic Treatment Unit

The first treatment unit, presented during the second quarter, was focused on kinesthetic learning. Learner grades were compared to determine how male and female kinesthetic learners fared when compared to peers of the same and opposite gender. During this unit, students were not required to sit in their desks. They were free to move as desired; they could lie on the floor, stand, or sit on lab stools in the laboratory. When notes were taken or students were given lectures, they were also given models. For example, when the properties of water were discussed the students were given models of atoms so they could build a water molecule and better understand how it looks and how the charges are distributed. During these lectures students were also shown kinesthetic "triggers" to help them remember information. For example students were asked to stand and act out the motion of molecules so that they could better understand the difference between a solid, liquid, and gas. When students were asked to read from the text in class,

they did it in the form of a reading migration. At the end of each page, students had to get up and walk to a Post-It check station. At these stations, scattered around the room, students had to write a question on a Post-It based on what they had just read. Then they could return to their original reading roost or they could select a new reading roost. After the section was read, students had to circle around the fringes of the room doing the section questions, which had been copied and taped to the wall. By the end of the class period, students had asked three questions and answered fifteen. At other times during the unit, worksheets were cut up and taped to the wall so that students had to move to complete them. Students also did partner reviews in which they wrote three questions based on the reading, found a partner, picked one of the six questions and answered it. Then, they rotated to a different partner, picked a new question and answered it. This process continued for six rotations, until they had answered six different questions with six different partners. By the end of the activity some groups ran out of questions, so they had to write a new question and answer it. An “attention deficit disorder” (so named by the students) worksheet was also created and given to the students on one of the days when a substitute taught the class. This worksheet was a supplemental worksheet that had been cut up and recopied so that the questions were scattered across the page and oriented differently. Students physically had to turn the sheet to answer all of the questions.

This unit lasted for 3.5 weeks and covered properties of water, basic homeostasis and transport, and well as the initial part of the biochemistry material. At the end of the unit, students were given an online survey that asked them to evaluate the class, the class dynamics, the overall appeal of the class, and their learning. Randomly selected students

were also interviewed and asked questions relating to the unit and their perception of the class. After each data collection, male and female grades were compared to determine if there was difference between the genders.

Auditory Treatment Unit

After the kinesthetic unit was completed, the class was presented with an auditory unit, which lasted three weeks. The material presented in this unit was limited to biochemistry and some introduction to cell structure and function. Lecture was again used in this unit, but every few minutes the students were asked checkup questions to determine if they could recall the material. During lecture students also built models and explained them to their partner as well as doing their questions and worksheets out loud. When the students were working on an oral worksheet they were sorted into groups and one answer key was given to each group. When students were ready to answer a question, they answered it out loud. A group member checked it, then signed the worksheet indicating whether or not the answer was correct based on the information from the key. During this unit, students also engaged in oral reading both with a partner and in groups. For these assignments, students were allowed to select their own groups/partners. In order to assess these assignments, the teacher migrated around the room and listened to the students working and asked questions of the students regarding the reading content. Students were also required to turn in written work, but it could be done with a partner then checked off by the teacher or her aide. At the end of the unit, students were given an online survey, which asked them to evaluate the class, the class dynamics, the overall appeal of the class, and their learning. Selected (randomly from the pool of students who had not been previously interviewed) students were also

interviewed and asked questions related to the unit and their perception of the class.

After each data collection, male and female grades were compared to determine if there were differences between the genders.

Visual Treatment Unit

The final treatment unit was based on the visual learning style. Material presented during this unit was limited to cell structure and function. During this 3.5 week unit, students were asked to complete illustrated notes as they worked through the chapter. Each student was given a handout of the teacher's normal PowerPoint presentation with space to draw pictures. As students read, they were required to draw a picture symbolizing the contents of the note slide and the material they had just read. Students also constructed a cellular gazette highlighting various parts of the cell and cellular functions. These newspapers required students to write articles about the cell and to illustrate the papers as well. Students were also asked to create graphic organizers and cartoons for assignments. The majority of this unit was spent working on the cellular gazette requirements, which have been included in Appendix B. At the end of the unit, students were again given the online survey and the remaining students were interviewed. Gender was again considered when comparing the grades of individual learners.

Composite Treatment Units—Intrapersonal and Interpersonal

In order to compare interpersonal learners and intrapersonal learners, individual assignments were compared. For example, the partner reading from the auditory unit was considered to be interpersonal whereas the illustrated notes from the visual unit were considered to be intrapersonal. A list of individual assignments considered interpersonal

and intrapersonal is included in Appendix C. These assignments were also compared with regard to gender.

Treatment Uniformity

Questions and assessments presented during the non-treatment and treatment units were somewhat standardized since the majority of the information was from textbook supplemental sources and included questions from the active reading guides, the supplemental section worksheets, the chapter test supplement, and the assessment items listed in the supplemental test generator. The assessment items were taken verbatim from these sources and presented in the different modalities during the treatment units. For example during the kinesthetic unit a supplemental worksheet was enlarged, the questions were separated, and then taped around the room. During the auditory unit a similar worksheet from the same source was used when the students were asked questions and had to present their answers orally. Through techniques such as above, the various treatments were fairly uniform and consistent.

Data Collection Tools and Techniques

Data were collected using the following techniques: BGfL online survey, pre-unit evaluation (online survey), unit evaluation (online survey), unit interviews, teacher generated assessments, classroom observations, and a teacher journal. With the exception of the BGfL online survey, all of the data collection tools were original and created for this project. In order to ensure that the rest of the data were consistent and reliable, an attempt was made to ask the same question several ways and the instruments were previewed by Rose Lundby-Powell, Madeleine Pitsch, and Craig Earley. Students were also given an opportunity to make comments on the units. During the interviews

students were asked questions regarding their personal learning styles, in order to answer these questions students had to reflect and think about their thinking style, engaging in metacognition and hopefully better understanding their own personal learning style.

They were also asked questions about what their peers thought or said in order to better understand the effects that the units had on classroom dynamics and student perception.

Table 1—Triangulation matrix below shows the data collection technique used and which research question(s) it answers.

Table 1
Triangulation Matrix

| Research Question | Data Source 1 | Data Source 2 | Data Source 3 | Data Source 4 | Data Source 5 | Data Source 6 | Data Source 7 |
|--|----------------------------------|------------------------|------------------------|-------------------------------|------------------------|-------------------------------|-------------------|
| <i>Primary Question:</i> | | | | | | | |
| What impact does instruction, differentiated with regard to gender and learning style, have on student performance and classroom dynamics? | Learning Styles Inventory (BGfL) | Student Surveys | Student Interviews | Teacher Reflections | Classroom Observations | Teacher Generated Assessments | Literature Review |
| <i>Secondary Questions:</i> | | | | | | | |
| 1. How do different teaching and assessment strategies affect overall appeal of the class and classroom dynamics? | Student Surveys | Student Interviews | Teacher Reflections | Classroom Observations | Literature Review | | |
| 2. How does the implementation of differentiated teaching and assessment strategies affect classroom management and dynamics? | Teacher Reflections | Classroom Observations | Literature Review | | | | |
| 3. What is the measurable relationship between gender and learning style modality? | Learning Styles Inventory (BGfL) | Teacher Reflections | Classroom Observations | Teacher Generated Assessments | Literature Review | | |
| 4. What are the impacts on the teacher? | Teacher Reflection | Literature Review | | | | | |

The Birmingham Grid for Learning (BGfL) Multiple Intelligences (Secondary) survey is a standard learning styles profile that is hosted online; a list of the questions asked in this survey has been attached in Appendix A. Essentially, this survey creates a graph of students' preferred learning styles (kinesthetic, linguistic, logical, interpersonal, intrapersonal, musical, visual/spatial, and naturalistic) and generates a raw score out of 25 for each of the learning styles. For example a student might score an 18 out of 25 for interpersonal, a 12 out of 25 for musical, and so on until each style has a score ranging from 0 to 25.

The student surveys were hosted online by [surveymonkey.com](https://www.surveymonkey.com) (Appendix D). These questions ask students to evaluate the lessons in terms of content, differentiation, and quality with regard to their learning style and gender. Randomly selected students were asked to participate in a follow-up interview at the end of each unit. By the end of the data collection period, 27 out of 32 students had been interviewed. Approximately one-third of the class was interviewed after each treatment unit. These interviews were designed to probe the students a bit more in order to further evaluate the treatment units. These interviews were especially designed to gauge classroom dynamics and overall appeal (Appendix E).

A teacher reflection journal was also kept during this research project. It contained notes, observations, and reflections based on lessons from that unit. These notes were an attempt to close the loop of learning so the teacher could analyze the success of the lesson and share that information with her students. This journal also contains most of the notes regarding gender interactions in the classroom. More formal classroom observations were also used during the course of the data collection. During

these periods, students were observed as they interacted and notes were taken.

Differences in behavior based on gender and gender interactions were the primary areas observed. An old notebook from the 2009-2010 school year containing observations regarding single gender classes previously taught was also used as a comparison to the current observations.

The two primary gender data collection techniques for the composite units were the classroom observations and the teacher journal. Classroom observations focusing specifically on students' interpersonal and intrapersonal actions were conducted twice during each of the solo treatment units. During these sessions, the teacher monitored student behavior and noted observations related to interactions between the genders and within the genders. Interactions of gender-mixed groups were carefully observed and were of special interest. For example, when boys were asked to partner read, they were observed to be engaged in kinesthetic tasks, whereas when the girls were partner-reading, they were very still and focused on their partner's words. Mixed groups usually varied in their behavior.

The final data collection tools were teacher-generated assessments given in class and included such items as daily work, labs, worksheets, and other types of reinforcements. These assignments were selected because they typify the type of work targeted by the treatment unit and are examples of assignments differentiated with regard to that learning style. The majority of these assignments were pulled from the textbook supplemental material in order to insure that the difficulty level of the treatment units was somewhat standardized, and also validity was better insured.

Each of these data collection tools was beneficial and useful in obtaining an accurate picture of the class performance and classroom dynamics. The student surveys and interviews were very insightful and generated many areas for further thought. Overall, the data collection was a success and helped create a picture of the life in a General Biology class in rural Southeastern Montana.

DATA AND ANALYSIS

Data generated by the BGfL online survey, pre-unit evaluation (online survey), unit evaluation (online survey), unit interviews, teacher generated assessments, classroom observations, and a teacher journal were examined. Each of the patterns mentioned herein strives to answer one of the fundamental research questions posed.

Gender, Learning Style, and Performance

BGfL Online Survey

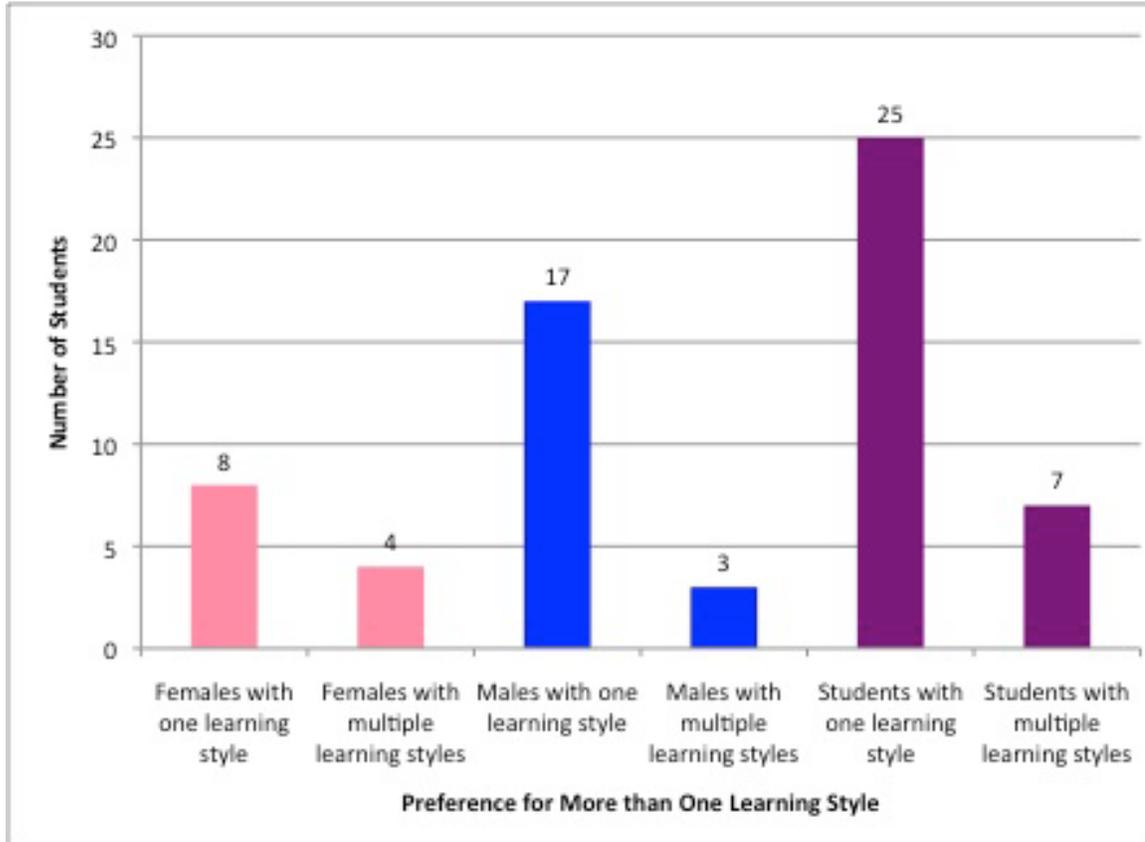


Figure 1. Student preference for more than one learning style ($N=32$)

The BGfL survey proved valuable in establishing a baseline for student learning style broken down by gender. Sixty-six percent of the females ($n=8$) had one preferred learning style; of those, 37.5% were intrapersonal, 25% interpersonal, 12.5% kinesthetic, 12.5% logical, and 12.5% musical. The remaining 33% of females ($n=4$) showed an equal preference toward more than one style; of those, three-fourths showed a preference toward the interpersonal learning style. Taking into consideration the entire female population ($N=12$) of this study, fully 75% of the females preferred either intrapersonal or interpersonal learning, as opposed to a specific sensory based learning style modality

(kinesthetic, auditory, visual). The remaining 25% preferred kinesthetic, logical, and musical learning style modalities.

Eighty-four percent of the males ($n=17$) had one dominant learning style; of those, 31.25% were intrapersonal, 25% interpersonal, 25% kinesthetic, 12.5% naturalistic, and 6.25% musical. Boys who showed an equal preference (meaning that they had the same raw score in several categories) toward more than one learning style ($n=3$) were in the minority at 15%, of the total male population. Every single boy with multiple learning style preferences listed the intrapersonal learning style as a preference. Fully 65% of all the males ($N=20$) either liked the intrapersonal or interpersonal learning style, 25% were kinesthetic, and the remaining 10% preferred the naturalistic or musical style. One male in the study did not take the learning style preference test, but he is on an IEP and has been shown (through resource room testing) to be artistic and prefer the intrapersonal learning style.

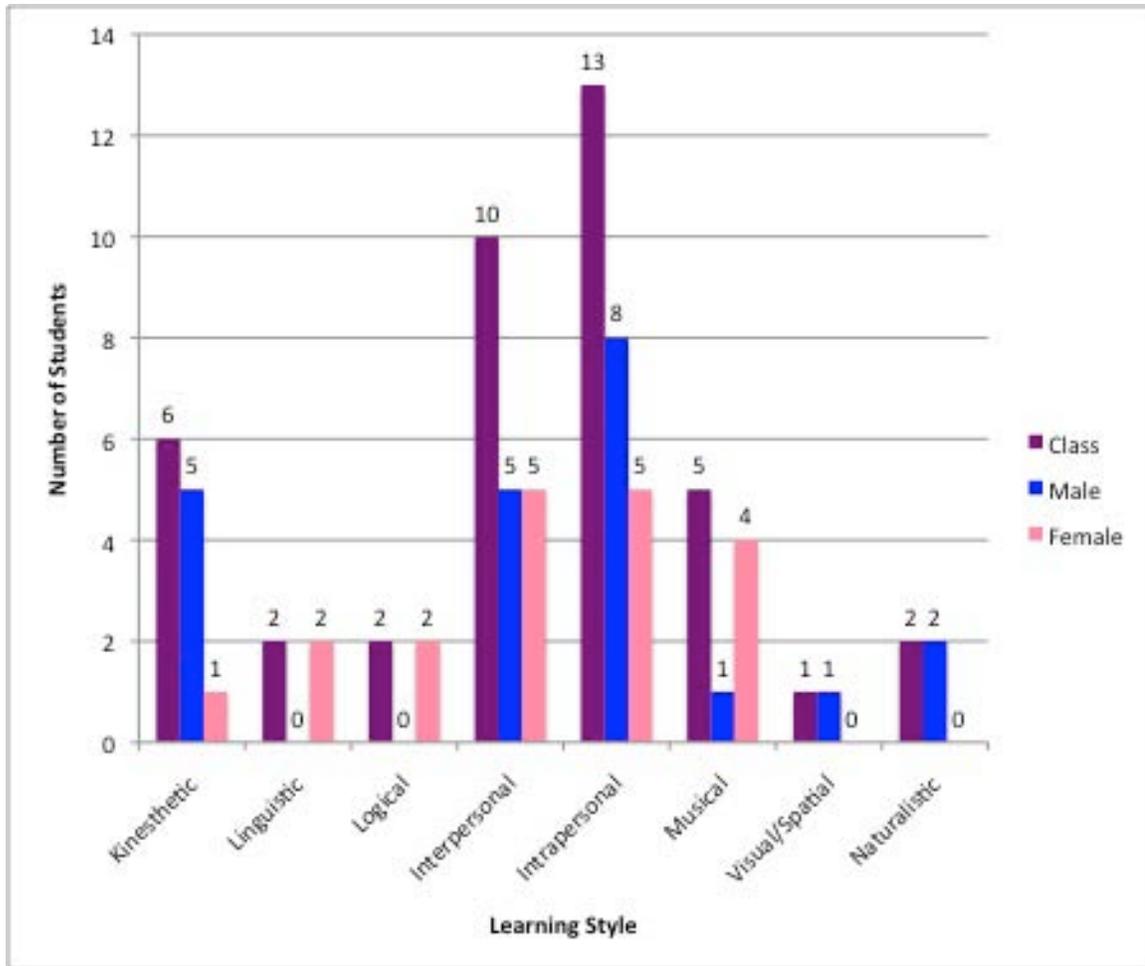


Figure 2. Learning style preference of whole class ($N=32$ students)

Students who showed a preference for more than one learning style ($n=7$) were counted more than once.

As a whole, the General Biology class of Powder River County District High School in Broadus, MT showed a distinct preference toward either the intrapersonal or interpersonal learning style. The major distinction between the genders was that 25% of the males ($n=5$) preferred the kinesthetic learning style (Interestingly, of this 25%, over half were males on IEPs.). This 25% of the male population was so strongly kinesthetic that they were able to skew the average of all raw scores. An initial analysis of raw data seemed to indicate that the preferred learning style for the class was kinesthetic.

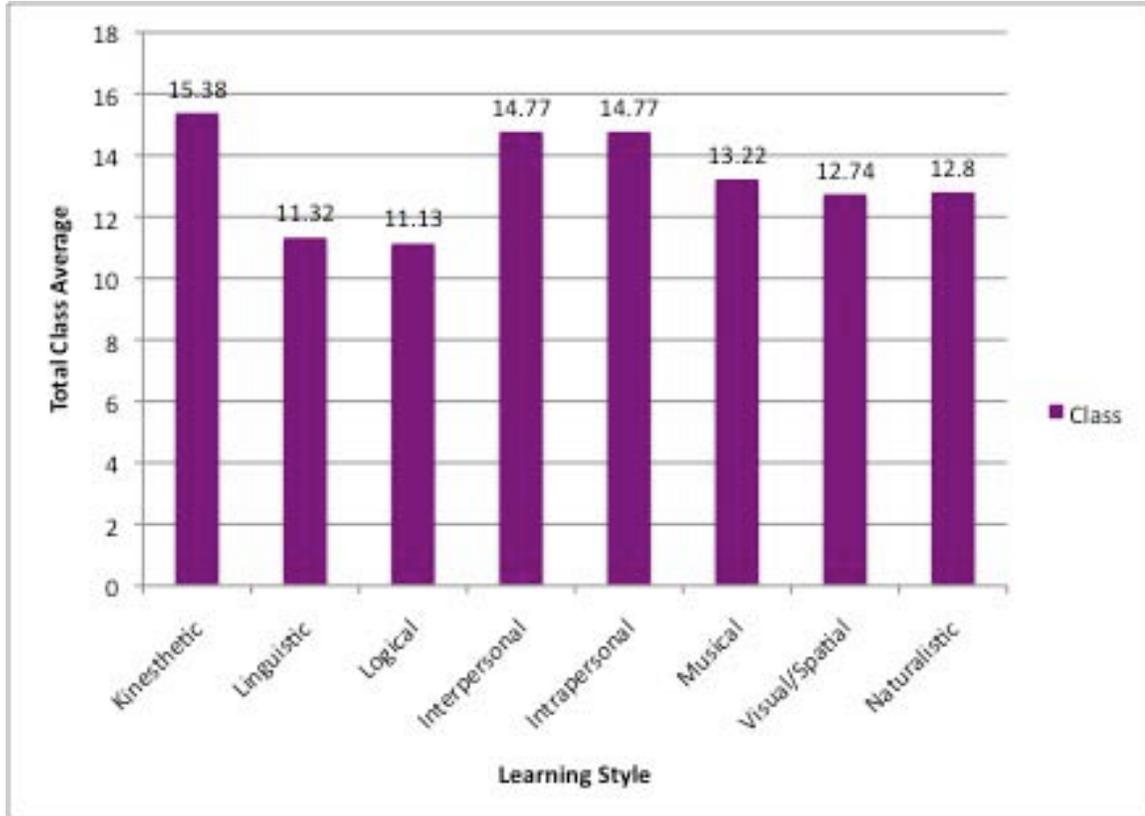


Figure 3. Average class score on the BGfL out of 25 ($N=31$)

A discussion of this kinesthetic trend will be covered in the conclusion of this paper.

However, more analysis revealed that most students were either intrapersonal ($n=13$) or interpersonal ($n=10$) learners. According to student interviews, most intrapersonal learners prefer to work independently at their own pace. While, an interpersonal learner prefers to work with a partner or in a small group; these students seen to benefit from a “group brain” and enjoy working with others to figure out the solution to a given problem. In order to accommodate both intrapersonal and interpersonal learners, some adjustments need to be made to the class so that students have the opportunity to work as both an individual and as a member of a group.

Teacher Generated Assessments

Interestingly, when students were broken down by in-class/assessment performance and learning style a secondary pattern between the genders was found. Four out of five females (one exception—intrapersonal) with A grades scored highest during the interpersonal treatment unit regardless of indicated preference for learning modality. Males with A grades were divided between four different learning styles (intrapersonal, interpersonal, kinesthetic, and visual). Most of the lower performing students were found to be kinesthetic males on IEPs; in fact six out of nine students with D or F grades were kinesthetic males on IEPs. Interestingly, these students also scored the highest during the interpersonal unit averaging a 73%. In interviews, these students mentioned liking group work because it gave them an opportunity to “talk about the answer and learn from [their] friends” (biology student, interview). These kinesthetic males on IEPs scored the second highest on the kinesthetic, intrapersonal, and auditory units each one averaging a 64%. These scores were higher than the 61% average from the non-treatment unit and the 57% average from the visual unit. The average students in class did not appear to perform better or worse on any particular treatment unit. Instead these students maintained grades between 70% and 80% throughout the research study.

However, there is a relationship between preferred learning style and treatment unit. Forty-six percent of students performed best on the treatment unit that matched their preferred learning style. An additional 21% score highest on the unit that matched their second choice learning style. Combining these accounts for 67% of the class; seeming to suggest that there is some sort of relationship between preferred learning style and in-class performance.

When students were broken down by in-class/assessment performance and indicated learning style preference, a second interesting pattern emerged. Regardless of gender, with one exception, students who showed a preference for an uncommon modality (logical, musical, naturalistic) were B+ or higher students. The outlier is an individual who is innately intelligent, but title qualified and has other possible cognitive processing gaps. He would benefit from a full battery of special education testing, but his parents refuse to sign the permission forms. With proper interventions his grade would probably increase dramatically. It makes one wonder if these students, with odd learning styles, learning needs are being inadvertently met or if these students have a natural inclination toward success in school, an argument could probably be made for both scenarios and will be discussed in the conclusion.

Student Interviews

Student interview revealed that regardless of gender most students were comfortable in class during the treatment units. In fact 25 out of 27 student interviewed indicated that they liked class better during the treatment units than during the non-treatment unit. Additionally, students noticed an improvement in classroom dynamics during the treatment routines. Sixteen out of 27 students interviewed thought that the dynamics improved during the treatment units when compare to the non-treatment unit, six thought that the dynamics were unchanged, and five indicated that the dynamics were worse overall. The five students who thought that the dynamics were worse were all male and three of them were juniors repeating the class.

Most of the positive comments generally indicated a preference for working as a group. For example, one male student stated that he learned better “when talking it over

and working together, [because he] could hear the answer and learn[ed] better that way” (male sophomore biology student, interview). Most of the negative comments were made by students who preferred to work by themselves and reflected the fact that these students thought there was too much chaos. “I didn’t really like it. I learn best when I’m off in the corner by myself” (male junior biology student, interview). Most of the students who indicated that the dynamics improved also reported that they thought their grades had improved. The data in this area were mixed, but students perceived an improvement in their performance.

Class Appeal and Classroom Dynamics

Likert Scales, Interviews, and Teacher Journal

The online surveys, Likert scales (Appendix D), were designed to determine how a treatment unit affected the overall appeal and classroom dynamics. These surveys yielded a wealth of qualitative data, but no significant quantitative data. For the most part, students were neutral to slightly positive in their responses; the scores averaged a 3.65 on a scale of 5. When paired t-tests were done to determine if there was a significant difference between the scores after each unit, none of the results were above a .03, indicating that there was no significant difference. Statistically there are no significant differences between any of the treatment units, or any of the treatment units when compared to the non-treatment unit. From a numerical standpoint, classroom dynamics and class appeal were unaffected by treatment units. However, the qualitative data revealed a slightly different picture.

The pre-evaluation (taken before the administration of any treatment units) comments were overall positive in nature. Fully 41% of the comments were positive and

related directly to the teacher's personality; the remaining 59% of comments were broken down as follows: 26% related to specific class content, 21% non-responses (typically consisting of a random string of letters or an emoticon), 5% negative, 4% neutral, and 3% other (responses which were not random letters, but could not be deciphered because they were written in "text" or the spelling and English grammar were so poor that the meaning could not be determined). One of the more exuberant responses was, "Torske is awesome" (biology student, online survey), while one of the more thought out responses was, "[s]cience isn't one of my strong subject[s] and I find it much easier to learn the way Mrs. Torske teaches rather than the way Mrs. [name removed] teaches" (biology student, online survey). "Ms. Torske is a good teacher," (biology student, online survey). This theme was expressed in several different ways, but overall the teacher and her class are very popular. This popularity appears to be independent of curriculum and differentiation because subsequent evaluations administered after each treatment yielded similar comments, "[t]was good" (biology student, online survey) and "[T]orske adjusts to the way [I] learn very well" (biology student, online survey).

Post-treatment evaluations and interviews yielded more comments directly related to differentiation rather than teacher popularity, but most teacher-related comments generated in subsequent evaluations were overwhelmingly positive. In general, the overall appeal of the class appears to be more closely related to the teacher's popularity than the content of the class. However, out of 27 interviews, 25 kids said that they liked the class structure better during the treatment units than during the first quarter (the non-treatment unit).

Of the five treatment units administered, the kinesthetic unit yielded the most polarizing results. Students either liked this unit immensely or disliked it with passion. In fact, Likert responses indicated that the majority of students thought that the material was well differentiated with respect to pace (43.3% indicated a 4 out of 5) and content (46.7% indicated a 4 out of 5). However, a large minority of students (13.3%) indicated that they thought the kinesthetic unit was not differentiated to meet their learning needs. In fact there were several comments along the lines of “I learn better by sitting in one place and concentrating on my work so when we did kinesthetic learning I found it was harder and had to sit down after and reread the chapter to take more away from it” (biology student, online survey) and “[i]t got kinda crazy and stuff. It would be better for me to sit and study diagrams and like the more visual stuff” (biology student, online survey). On the other hand, positive comments generally were expressed like this: “I like how we get up and move to wake us up and gets us involved” (biology student, online survey) and “it was fun” (biology student, online survey).

An interesting trend, was noted when randomly selected students were interviewed regarding the kinesthetic treatment unit. In general, female students with an intrapersonal learning style strongly disliked the kinesthetic unit, while males with a preference for the kinesthetic learning style liked the unit. An intrapersonal female said of the kinesthetic unit; “[I]t seemed chaotic and was noisy.” She also noted that her grades decreased during the unit. A male kinesthetic learner on an IEP stated that he liked the unit because “it’s not just so much sitting there writing...it helps me form more better understandings in my brain.” It should be noted that this male student switched class periods prior to the administration of the treatment units, and he commented on this

as well: “I like the smaller class better, it is less crazy.” A further discussion on the intrapersonal female vs. kinesthetic male will follow in the conclusion.

The auditory unit was the least liked by both the teacher and students. Notes in the teacher journal reflect an increasing frustration as the unit progressed. One of the last comments on this unit was, “I cannot wait until it is time to switch treatment units, my student’s grades are dropping and I’m tired of all the whining” (teacher journal, 2010-2011). Student responses on the Likert surveys also supported this trend. Twenty-one and a half percent of the class indicated that this unit was not differentiated with regard to their learning styles. Additionally, the responses generated by the statements *I felt this unit was differentiated in terms of material delivery* and *I felt this unit was differentiated in terms of assessment method* were lower than any of the other units. The average responses for these questions were 3.57 and 3.52 on a scale of 5, respectively. Average responses to these statements on other survey were 4 or above. A majority (68.75%) of student grades also dropped, during this unit, by an average of 4.68% when compared to the non-treatment unit.

The interpersonal unit was the most popular unit. A majority of students interviewed indicated that they enjoyed learning in groups and interacting with their peer. Notes from the teacher reflection journal also seem to support the students’ conclusions. “Today the kids are really on task and working hard I think this [cellular gazette] is really working well. Hopefully they will be able to produce good quality products” (teacher journal, 2010-2011). Interestingly, during this unit 65.63% of students experienced higher grades, an average of 8.7%, than during the non-treatment unit. Of the 34.37% of

students whose grades dropped 36% were intrapersonal learners, which represented the largest group of learners in this minority.

In general, the overall appeal of the class is affected by two factors: teacher popularity and differentiation. Differentiation leads to an overall positive appeal. However, it is secondary to teacher popularity. When these two factors are aligned, the result is a very popular class that appeals to most students. In the words of one student, “Bio is my favorite class and [I] understand it for the most part.”

Classroom Management and Dynamics

Differentiation has a positive affect on classroom management and classroom dynamics. In general, students were engaged in the class regardless of the treatment unit. However, the classroom management was much easier during the treatment units than it was during the non-treatment unit. A journal entry dated September 14, 2010 stated that, “the kids were hard to manage today. It seems as if they are hot and squabblely. I wonder if they would work better if they could lay on the cool floor” (teacher journal, 2010-2011). This entry was interesting to compare to one written during the kinesthetic unit dated November 17, 2010, “[t]he kids seem happy, they are sprawled out on the floor and working in groups. Noise is not a problem” (teacher journal, 2010-2011). During the treatment units, when students were allowed to choose how they wanted to sit, stand, or lay in class, they were generally more at ease and worked harder on the task at hand. In general, the more freedom the kids were given, the happier the teacher and students were and the greater the amount of productive work was done. An analysis of the observation rubric from November 17, 2010 seems to indicate that the students were on task most of the time. On that particular day, 85% of the students, regardless of gender, were noted as

“on task,” 10% were ranked as “slightly off task” (these students worked for the most part, but were also observed gossiping), and the remaining 5% were ranked as “off task/distracted” (these students were either sleeping or working on English). The vast majority of the “on task” students were working at locations around the room which they had sought-out. Many of the “off task” students were seated in their desks frantically working on their English, the rest were scattered around the room like the “on task” students. “Slightly off task” students could also be found at their desks and around the room.

Classroom dynamics were a bit more interesting. Students tended to work with the same people (or alone) regardless of the treatment unit. When the groups were teacher selected, or when students were forced to work independently, the amount of complaining increased dramatically. A journal dated December 1, 2010 noted that, “I had to put the kids in silent lock-down mode today because they were whining so much about having to do the assignment by themselves. When is Christmas break?” (teacher journal, 2010-2011). It was also noted during classroom observations that the kids were flirting, and when they were flirting the volume of the class would increase. These dynamics were especially interesting when compared to a journal kept the previous year, when three gender homogenous classes were taught. “I cannot believe how nice it is to teach classes with only one gender, everybody gets along and they are on task most of the time, no flirting, pestering, or bugging their classmates. WOW!” (teacher journal, 2009-2010). Also an analysis of a behavior rubric, from December 1, 2010, seems to indicate that a lot of students spent time making unnecessary trips around the room and would engage other students during these trips. One individual made five trips to the pencil

sharpener, two trips to the garbage can, one trip to the Kleenex box, and three trips to the supply table, on each trip he tried to engage other students in the class. When he did finally settle into his seat he spent the bulk of his time staring at the ceiling. It should be noted that this student has a B average and has a strong preference for interpersonal learning.

While in general classroom dynamics and class management were not significantly impacted by the various differentiated assessment and teaching techniques, the overall experience was positive. When the 2010-2011 school year was compared to the 2009-2010 school a year a dramatic change was noted by the teacher/researcher. In general the homogenous classes were easier to manage and teach.

INTERPRETATION AND CONCLUSION

The results of this research paint an interesting mixed picture, much like the results of other research. Each of the research questions was answered and several trends were found that need to be explained in some detail. This research has provided the administration, teachers, special education teacher, and parents with valuable data. The administration and staff of Powder River County District High School have been able to better accommodate the students as a result of this research project. It has also provided this particular teacher useful and interesting feedback on her teaching techniques and strategies.

One Learning Style vs. Many Learning Styles

The first trend that needs to be mentioned is the dominance of a single learning style preference. One-third of the females have an equal preference for more than one learning style. One-fifth of the males exhibit this same tendency. Combined this accounts for 25% of the entire biology population. With one exception (a male on an IEP) these are the top students in class, they have the highest grades, participate the most in class, and are the most engaged. This fact would seem to suggest some correlation between multiple learning style preferences and in-class performance. It makes one wonder if students with greater learning style flexibility are naturally better at school or if they have developed this flexibility as a result of school and are therefore more successful. Perhaps there is some underlying factor such as natural intelligence that accounts for both patterns. There is no way that the current study could be used to determine causation, but it would be an interesting area to research.

On a related note, students with a preference for an uncommon learning style (naturalistic, logical, musical) were without exception B+ or higher students. Two explanations for this trend immediately come to mind. The first being that these students are being inadvertently served in the biology class studied. Students with a naturalistic learning style preference could be extremely interested in the biology content; they might succeed regardless of the differentiation, teacher, or instruction techniques. These students might be the ones who would naturally pick up and enjoy biology. Secondly, students with a preference for the logical learning style may have their needs met by the very nature of science education. For the most part, science consists of a series of steps; this fact could appeal to students who are very logical in their thinking. Finally, students who are musical in their learning style preference may be having their needs met because

the teacher is an auditory learner herself who plays music in the classroom on a daily basis regardless of differentiation technique or phase of research (non-treatment or treatment unit).

The second explanation for the fact that uncommon learners perform very well in class could have nothing to do with the class or teacher. It may simply be related to the fact that these students are naturally more intelligent and would succeed in class regardless of any factor studied. The researcher was not able to gain access to these student's grades from other classes, however she was able to gain access to the class rank data. Students ranked first, second, fourth, sixth, seventh, and eighth all preferred one of the odd learning styles or multiple learning styles.

The Kinesthetic Trend

The second trend discovered during the data analysis was dubbed the kinesthetic trend. There are two primary reason for this kinesthetic trend: 1) many students showed some preference for kinesthetic learning even if it was not their highest score, and 2) the males on IEPs with a kinesthetic learning style showed minimal preference for any other learning style. Basically, the average of the raw learning scores for all the classes gave the impression that kinesthetic was the preferred learning style of the class a whole. The average kinesthetic score was 15.38 out of 25. An initial glance at the data seemed to indicate that the class as a whole preferred kinesthetic learning. However, more analysis revealed that interpersonal and interpersonal actually occurred more often as a primary learning style among the students. It is interesting to note that when looking at the average class score by treatment unit, the highest score occurred during the interpersonal

unit; this score was an 80% while the rest of the scores ranged from a 75.2% (visual) to a 76.8% (kinesthetic).

The males on IEPs (it should be noted that males who were title qualified were also included in this group) with a kinesthetic learning style ($N=7$) are being underserved in class. They have on average an 18-39% lower grade than males who are not on IEPs ($N=13$) and 15-38% lower grades than the females ($N=12$). It should be noted that there are some non-IEP males who have grades in excess of 100%, so the average of the non-IEP males is a bit high. If these high grades are removed from the average the difference is still 18-38%. The two treatment units with the lowest gaps, between IEP males and non-IEP males, are not surprisingly the interpersonal and kinesthetic units. It appears as if males on IEPs with a kinesthetic learning style need differentiation in order to have success in this particular biology class. Interestingly, the kinesthetic males saw on average a 3% increase (one student's grade jumped 13%) in their grades, while the female intrapersonal learners saw a 3% drop in their grades during this same unit. Which brings us to the second trend worth discussing in great detail: the intrapersonal female vs. kinesthetic male dilemma.

One interesting outlier must also be discussed in this section. One girl in the class was extremely kinesthetic in her learning style modality preference. This girl is very athletic and comes from a family that seems to always be in motion. Her data follow the same trends as the male kinesthetic learners on IEPs. She is a B average student and works very hard in class. However, her grades improved (5%) during the kinesthetic unit and fell (3%) during the intrapersonal unit. It was surprising that the trends in her data so

closely followed the male kinesthetic trends. She would make an interesting case study for further research.

Intrapersonal Females Vs. Kinesthetic Males

The third trend that needs additional discussion is the intrapersonal female vs. kinesthetic male (especially kinesthetic males on IEPs) dilemma. Throughout the course of this research it seemed as if these two groups were always at odds, although there were no personality clashes. It seems as if these two groups have very different needs. The intrapersonal female prefers a very quiet classroom and in general likes to work away from everybody in her own world. The kinesthetic male prefers a classroom that is loud, in perpetual motion, and very interactive. When the class was adjusted to accommodate the kinesthetic males the intrapersonal females grades dropped and vice versa. Figure 4 is a graph of the grades of female intrapersonal learners and kinesthetic males on IEPs. The females consistently had higher grades, but there is still a trend visible when looking at rises and falls in the grades.

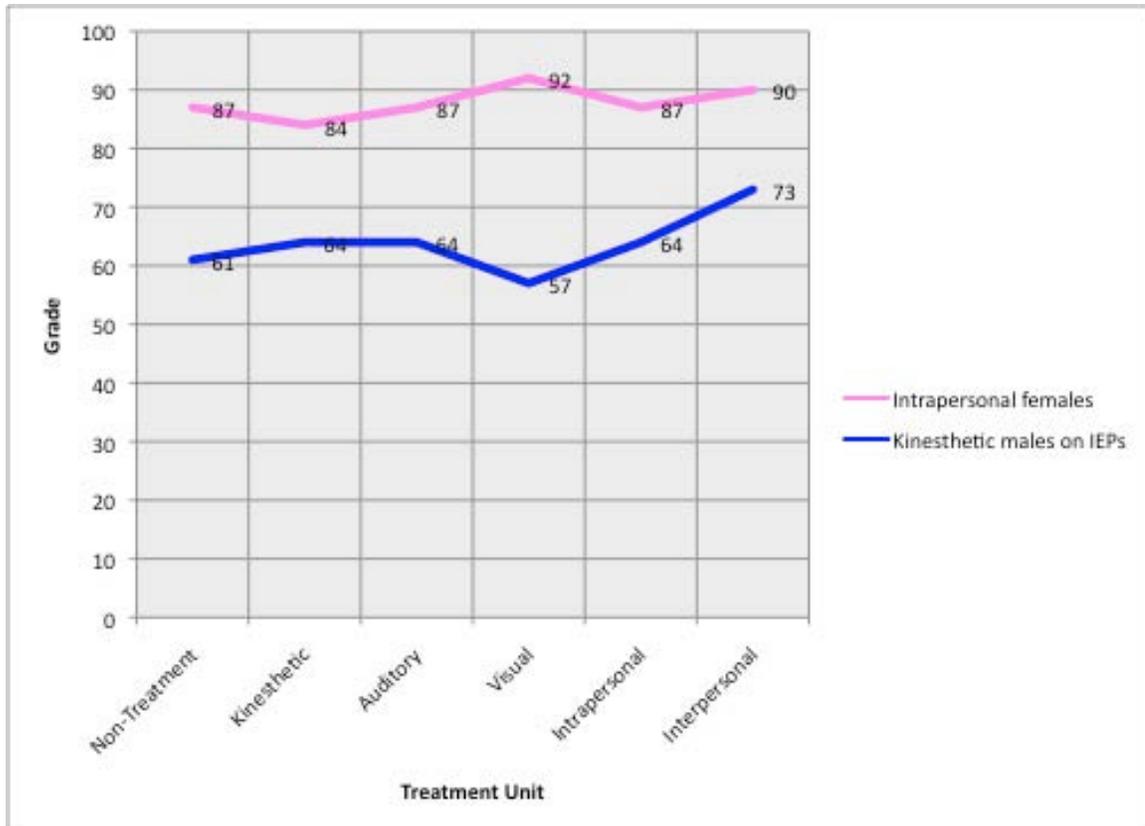


Figure 4. Intrapersonal female grades vs. kinesthetic males on IEPs grades by treatment unit

This brings up an interesting dilemma—which group should be accommodated and which group is accommodated. A further discussion of the ethical implications of this finding will appear in values section.

Final Conclusions—The Big Picture

Beginning with the primary research question: What impact does instruction, differentiated with respect to learning style and gender, have on student performance and classroom dynamics? In general (regardless of gender) when student learning style and differentiation technique match, student in-class success increases. Forty-six percent of the class (both male and female) scored the highest on the unit that matched their learning style ($n=15$). An additional 21% of the class scored the highest on the unit, which

matched their second preference in learning style. Overall, 67% of the class scored the highest during either their most or second most preferred learning style treatment unit. Only two students scored higher during the non-treatment unit. This would seem to indicate that differentiation resulted in higher grades than in a traditional classroom. Based on qualitative data, classroom dynamics also improves with differentiation; 93% of interviewed students preferred the treatment (differentiated) units to the non-treatment unit. In addition, the teacher much preferred the overall class dynamic during the differentiated units than during the non-treatment unit.

Moving on to secondary research questions: one, how do different teaching and assessment strategies affect the overall appeal of the class and classroom dynamics? Teacher popularity needs to be taken into consideration, but differentiation improves both the appeal of the class and the classroom dynamics. The online unit evaluations (submitted by all students present on evaluation days), interviews ($n=27$ out of $N=32$), and teacher journal seem to support this statement. Ninety percent of online evaluations (for all units) are positive in nature, 93% of student interviews revealed a preference for differentiation, and the majority of entries in the teacher journal extol the value of differentiation.

Two, how does the implementation of differentiated teaching and assessment strategies affect classroom management and classroom dynamics? In general differentiation improves classroom management, but has minimal effect on class dynamics as long as students are allowed to select their own partners. According to the teacher journal entries, students were less likely to complain or be off task if they were allowed to select their working situation.

Three, what is the measureable relationship between gender and learning style modality (kinesthetic, auditory, visual, interpersonal, intrapersonal)? Seventy-five percent of females and 64% of males either prefer intrapersonal or interpersonal learning, but there is a measurable sub-population of males (26%) that prefer the kinesthetic learning style. Some of the trends generated during this portion of research seem to support some of the common gender stereotypes. Particularly that females are more social and perform better when allowed to interact in a group: four out of five females with A grades scored the highest during the interpersonal unit. Additionally, the stereotype that males need to move in order to learn is partly supported by the fact that 9 out of 20 males scored higher during the kinesthetic unit than during the non-treatment unit. This stereotype appears to apply particularly to males on IEPs. Their grades jumped significantly during the kinesthetic unit.

VALUE

This study was very valuable to the researcher/teacher. Of foremost importance was the kinesthetic male vs. intrapersonal female dilemma. The kinesthetic males in this class are underserved and more should be done to improve their grades, but doing this negatively impacts the grades of female intrapersonal learners. Quantitative data from individual student performance seems to support this statement. Six out of seven males with IEPs or title qualified saw at least a 3% increase in their grades. During this same period five out of eight intrapersonal female learners saw their grades drop. Qualitative data also seems to support this statement. When two of the affected males were

interviewed with regard to the kinesthetic unit they expressed a strong affinity for the unit. Conversely, three of the affected females complained and one set of parents came in expressing concern over the drop in their daughter's grades during this treatment unit. From an ethical standpoint, this dilemma has no correct solution. From a practical standpoint, more should be done to help the kinesthetic male learners. In general the intrapersonal females had very high grades and even though their grades dropped by an average of 3% they still maintained a B+ average in class. However, the kinesthetic males' average gain of 3% moved many of these students' grades to passing for the first time all year. In some ways the success of the boys (passing for the first time) outweighs the harm to the girls (getting a B+ instead of an A-).

A great deal of thought and time was given to the previous statement. One of these thoughts is based on the composition of the faculty of Power River County District High School. This staff is primarily female, within ten years of retirement, and probably does not favor the kinesthetic learning style. This faculty probably, as a whole, favors intrapersonal female learners. Consequently, kinesthetic males with IEPs are underserved all day long which probably creates a wide variety of problems, including low-self esteem, disinterest in school, chronically low grades, and general dislike of education.

Along these lines another topic must be discussed: is it important to expose students to a variety of learning style modalities to prepare them for a diverse work environment? In general, yes, however when students are predominantly oriented toward one modality then they need exposure to that modality on a regular basis in order to feel as if they are successful in class. The teacher/research for this study is an

auditory/intrapersonal learner who scores very low on a kinesthetic preference scale, consequently, this one area where she rarely differentiates. This fact is something she needs to keep in mind because 26% of her male learners are not having as much success as possible in her class. Consequently, differentiation with regard to kinesthetic learning has become a priority because it one area where she does not automatically differentiate.

Additionally, this study helped reinforce the idea that differentiation based on modality is valuable and worthwhile in a secondary biology class. Although the quantitative data generated for this study do not support this statement, the qualitative data does. Overall 93% of interviewed students preferred the differentiated units to the traditional teaching unit during the first quarter. If the students and teacher feel like they are comfortable in class as a result of the differentiation then perhaps learning really does increase. Though in-class performance may not increase, the perception is overall positive, so there maybe an unmeasured factor which increases the productivity in the differentiated class. In general the teacher/research would rather teach in a differentiated class than a traditional classroom. Perhaps this differentiation will help prepare the students for a 21st century workplace where technology dominates.

Based on the research from this study several things have change in the teacher/research's classroom. Students are allowed to select where and how they want to sit and are often allowed to select with whom they work or if they want to work alone. Students are also allowed to move around the room freely as long as they are on task. More kinesthetic differentiation has been adopted and students do less deskwork. On occasion students can opt-out of the classroom to go to the library or an empty classroom near by to work by themselves in a quiet environment. The time spent on one task

during a class period has also been shortened so that students can work on a greater variety of topics and in a number of ways during the class period.

Finally, this study may be useful to the administration of Powder River County District High School in that it identifies students who perform better in differentiated classrooms. Perhaps this information will be helpful in customizing the education for the kinesthetic males on IEPs.

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APPENDICES

APPENDIX A

BIRMINGHAM GRID FOR LEARNING (BGFL) MULTIPLE INTELLIGENCES
(SECONDARY)

Birmingham Grid for Learning-Multiple Intelligences (Secondary) (This survey is hosted online at the following web address

http://www.bgfl.org/bgfl/custom/resources_ftp/client_ftp/ks3/ict/multiple_int/questions/choose_lang.cfm)

Participation is voluntary and will not affect your grade.

Rate the statements below according to the following scale—“This is not like me at all,” “I am very rarely like this,” “This is a bit like me,” “This is sometimes like me,” “I am like this more often than not,” “I am always like this.”

1. Pollution makes me angry.
2. I always do things one-step at a time.
3. I like to think out loud.
4. I enjoy games involving other people.
5. I like to make lists.
6. I need to see something in it for me before I want to learn something.
7. My mood changes when I listen to music.
8. I like to use charts and diagrams in my learning.
9. I like to think through problems while I run or walk.
10. I enjoy social events like parties.
11. I like working and thinking on my own and quietly.
12. I find it easy to explain things to others.
13. I am interested in why people do the things they do.
14. I enjoy making music.
15. I can pick out different instruments when I listen to a piece of music.
16. I like to work with a team
17. I can recognize and name the different types of birds, trees, and plants.
18. I have a good sense of direction.
19. I am good at mathematical problems and using numbers.
20. I enjoy writing things down.
21. I can link things together and pick out patterns easily.
22. I like or keep pets.
23. I get restless easily.
24. I can take things apart and put them back together easily.
25. I learn well from listening to others.
26. I can use lots of different words to express myself.
27. I have a good sense of balance and like to move around a lot.
28. I enjoy logic patterns and puzzles.
29. I am sensitive to the moods and feelings of others.
30. I remember things like telephone numbers by repeating them to a rhythm.
31. I can sort out arguments between friends.
32. I am observant. I often see things that others miss.
33. I enjoy being outdoors when I learn.
34. I know myself well.
35. I can remember pieces of music easily
36. I like to work with my hands

37. I am an independent thinker. I know my own mind.
38. I enjoy working on my own.
39. I can picture scenes in my head when I remember things.
40. I learn best when I have to get up and do it for myself.

APPENDIX B

CELLULAR GAZETTE REQUIREMENTS

Cellular Gazette (50 pts)

You and your partner will construct a Cellular Newspaper. Your paper must include the following:

Features:

An article about **each** of the following. Each article must include 5 vocabulary words from the book (underline them).

Nucleus
Mitochondria
Endoplasmic Reticulum
Golgi Body
Cytoskeleton

Editorial:

One editorial written about an issue important to the cell. Some ideas include:

Cloning
Stem Cells
Genetic Modification
Others?

Comics:

Two comic strips on the function of a cellular component. Ideas
Cell walls Vs. Cell membranes
Cilia Vs. Flagella
Smooth ER Vs. Rough ER

Highlights/pictures:

Your paper must include pictures and short highlights about the cell (3 of each minimum)

Drawn
Cut from magazines
Collage

Letter to the editor:

One letter to the editor written about a cellular issue. Some ideas include:

Cloning
Stem Cells
Genetic Modification
Others?

Advertisement:

Two advertisements for something made for or used in the cell

Pictures
Cut from magazines
Drawn

Prices
Testimonials?

Obituary:

One obituary written about a famous cellular scientist

Robert Hooke

Anton van Leeuwenhoek

Mattias Schleiden

Theodor Schwann

Others?

Grading:

| | |
|----------------------|---------------|
| Participation points | 10 pts |
| Quality | 15 pts |
| Content | 15 pts |
| <u>Creativity</u> | <u>10 pts</u> |
| Total | 50 pts |

Advise:

Be creative

Plan out the paper

Stay on task

APPENDIX C

LIST OF INTRAPERSONAL AND INTERPERSONAL ASSIGNMENTS

Assignments included in the intrapersonal treatment unit:

- Quarter Projects 1-4 (4 assignment total)
- Element Crossword Worksheet
- Section 3-1 ADD Worksheet
- Reading Migration
- Properties of Water Lab

Each of these assignments was done when the students were working independently.

Assignments included in the interpersonal treatment unit:

- pH/Buffer Lab
- Chapter 2 Practice Test
- Balancing Chemical Equations Worksheet
- Partner w/ Sticky Review
- Sticky Notes on the Wall
- Section 3-3 Worksheet
- Chapter 3 Practice Test
- Enzyme Lab

Each of these assignments was done while the students were working with partners or in small groups.

APPENDIX D

STUDENT SURVEY QUESTIONS

Unit Evaluation Survey Question List (These questions are hosted on [surveymonkey.com](http://www.surveymonkey.com) at the following web address <http://www.surveymonkey.com/s/J3K55WX>)

Rate the following on a scale of 1-5 (1= Strongly Agree, 5=Strongly Disagree)
Participation is voluntary and will not affect your grade.

1. This unit matched my learning style in terms of pace _____.
2. This unit matched my learning style in terms of content of material _____.
3. I felt that this unit was differentiated in terms of material delivery_____.
4. I felt that this unit was differentiated in terms of assessment methods _____.
5. I felt that this unit was differentiated in terms of content of lesson_____.
6. I felt that this unit was geared toward me with respect to my ability_____.
7. I felt that this unit was geared toward me with respect to my learning style_____.
8. I felt that this unit was geared toward me with respect to my gender_____.
9. I felt like my learning needs were accommodated by this unit_____.

Answer the following questions and comment on them

10. In your opinion, how did the unit affect classroom dynamics?
11. How did this unit affect the overall appeal of the class?
12. One thing that I would change about this unit is...

APPENDIX E

STUDENT INTERVIEW QUESTIONS

Interview Question List

Participation is voluntary and will not affect your grade.

1. How do the classroom dynamics now compare to the dynamics from last quarter?
 - a. How have the interactions changed?
 - b. Explain in detail.
2. What was your comfort level in class during the kinesthetic unit when compared to the first quarter?
 - a. Did you enjoy all of the movement?
 - b. In general, how do you think your classmates felt about the movement?
3. How do you think your grades and in class performance were affected by the movement during the kinesthetic unit?
 - a. Was the class structure okay or do you need more structure to succeed?
 - b. Was the movement okay or do you need more stillness to succeed?
 - c. How do you think the unit affected your classmates' performances?
4. Compared to the first quarter is Biology more or less appealing?
 - a. Is this because of the material or the teaching style changes?
5. How do you enjoy learning?
6. What can I do to increase your success in class?