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The Effects of Classroom Seating on Students' Performance in a High School Science Setting

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The Effects of Classroom Seating on Students' Performance
in a High School Science Setting.

By

Brian J. Minchen

May 2007

A thesis submitted to the Department of Education and Human Development of the
State University of New York College at Brockport in partial fulfillment of the
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Abstract

This thesis studied the effects of a student's location in the classroom versus their retention and application of newly learned material. The study's participants were students taking Regents Chemistry in a suburban school located in Upstate New York. Through a teacher administered questionnaire, students answered three questions regarding the lesson that was just presented. These questions followed a general pattern. The first question was usually simple recall, the second question was a more detailed recall mentioning specifics from the lesson, or on any experiments or demonstrations that were performed. The third question was an application of the lesson's principles. The students either had to create an application, or apply what they learned to a new problem. Students were also asked to identify their seat location within the classroom. The questionnaires were given out after a lesson where new material was presented. The students were randomly moved prior to and at the midpoint of the study, which lasted approximately three weeks.

Results showed that students who sat in the front of the classroom, defined as the first two seats in each row, consistently did better than those towards the back of the classroom. Various distractions such as windows, ventilators and other students were also taken into consideration and discussed.

Chapter One: Introduction

I can remember clearly when I first started school. My mother would walk me out to the bus, and wave good-bye as that faded yellow bus headed in the direction of school. Every year, she would always say the same thing as I left her behind. "Make sure you get a seat in the front!"

My mother, like most, assumed that if I sat in the front of the classroom I would perform better, learn more and be more successful. I obviously wanted these things as well, so I took her advice. I sat in the front, tried hard and generally found myself at the top of my class. Although I do not attribute all of my success to my location within the classroom, I have little doubt that it negatively affected my performance.

As I pondered what to do for my action research project, my mother's words rang in my head. I wanted to research an applicable topic, one that I could integrate directly into my classroom. I found myself constantly coming back to the same topic: classroom location.

I have been blessed by having a wonderful classroom for my students. It is a large, spacious room with an integrated lab in the back; plenty of space to store materials and a wonderful view of our school's courtyard in the center of the building. My room, however, has one distinct disadvantage. It is narrow. As a result of this configuration, my students sit fairly close to each other, and I only have five rows. Similar classrooms in the building have at least six, with another chemistry teacher having seven. I began to wonder if the configuration of my classroom had

anything to do with my students' success. Moreover, does the reduced number of front seats have a negative affect on my students? Out of that my research was born.

Problem Statement

To test my questions, I came up with a clear, measurable question that I could pose, and thus would form the basis of my research and testing. Does a person sitting in the front row of a classroom do better than a person sitting in the rear of the classroom? Once the answer to that question is found, then successive questions follow, such as why, and what factors are influencing that person? In addition, does that person do better because more motivated students chose to sit in the front row, or does sitting in the front row makes that person more motivated?

Significance of the Problem

The significance of these questions is universal. Every teacher who has more than a few students must deal with where the students will be located. If the student is located in an area of the classroom where there is statistical data to show poorer performance, then are they truly getting the best education possible? Is it fair to let students choose where they want to sit, if the front seats "guarantee" better performance? How does a teacher realistically deal with discrepancies in learning due to student location in the classroom?

Purpose

The purpose of the research is to determine if there is a correlation between seating location and student performance. Any correlations found can be used to design effective seating plans and appropriate changes, should situations change. The

research might also be used to help teachers who have students who are struggling. If seat location can be shown to have improved learning potential, then it should be considered when assigning seats or writing behavior management plans.

Rationale

The rationale behind the research was simple. I wanted an applicable topic that I could use in my classroom. I also wanted to share my findings with other teachers, in the hopes that they could design their classrooms with the most knowledge possible about how location affects our students. It is through this research that I am able to accomplish both of these tasks.

Conclusion

In conclusion, I wanted to study the affects of classroom position on students. The goal was to find if there was any correlation between the students' position in the classroom, whether voluntary or involuntary, and their retention of material. I had multiple reasons for researching this topic. First, it was applicable to my classroom, required no monetary resources, and could help behavior issues and ensure positive learning throughout the classroom. Second, it is universally applicable to teachers everywhere. Finally, it offered a chance to explore something my mother had been saying for years. Was the front seat really the best, or what is just a myth?

In my action research, I am primarily interested in three questions: Where in the classroom is the most efficient and effective learning happening? What classroom arrangement most effectively compliments my teaching style? How does a student's position in the classroom affect his or her performance in the class?

I plan to measure class performance by distributing a questionnaire to students after each lesson that contained new material. The questionnaire will have three questions based on the day's lesson. After answering the three questions, the students will mark on the sheet where they sat during the lesson. These questionnaires will be graded and the results will be tabulated based on seat location. The students will be randomly arranged when the study starts, and again halfway through. The results of these questionnaires will determine where the best learning is taking place, and how the student's location affects their performance.

In order to judge how my classroom arrangement compliments my teaching style, I will keep a journal throughout the study. In this journal, I will write observations about the class, problems encountered and how I felt the class went as a whole. This will primarily be to assess classroom management, and to give more subjective observations to the research.

Chapter Two: Literature Review

Introduction

A student's educational experience is often much more than just tests, quizzes and homework. It is also influenced by a number of environmental factors. One of those factors is how the classroom is prepared. Depending on the district and the liberty given, teachers can have a huge impact on the students with some simple changes. For example, if a teacher wants their room to be calm and soothing, they can use colors to their advantage. Hanging posters or painting their walls in blues and greens makes for a relaxing environment. Wacky? Try some tropical colors. If they desire a more warm and homey feel they can choose primary colors or earth tones for their classroom ("Eight secrets of class design," 1997). Although some of these changes might be outside the teacher's jurisdiction, the design of the room in terms of posters and materials is often under their control. Teachers could advocate having carpeting installed if it is not currently. The color of this carpeting could have a profound effect on the students to either excite or relax them (Hawkins, 1997). Even lighting could be considered. Most lighting in schools today is done through fluorescent lamps, presumably because of the low cost to operate, long lifespan and bright light they produce. If a bulb that produces a cooler color temperature is used, it can create a cooler feel to the room. A more neutral lamp would allow for a fuller spectrum of colors to emerge and could warm up the color palette of the classroom (Hawkins, 1997). The environment the teacher chooses will very likely have an effect

on the students, and the teacher's awareness of these principles can either help or hurt their success.

It has been suggested that a student's success within the classroom can be attributed to their individual learning styles coinciding with the classroom's style of teaching. A disconnect between learning and teaching styles has been attributed to misbehaviors and poor performance (Baum, Renzulli and Hebert, 1995). This indicates that environmental changes can solve, at least partially, some types of bad behavior as well as improve a student's performance in the class.

Numerous studies have shown that a student sitting in the front of the class will outperform students seated in other areas of that class. This has been shown to be true regardless of a student's preference. Although some students would prefer to sit towards the back, when they are brought up to the front, performance increases markedly (Totusek and Staton-Spicer, 1982). It is believed that the front of the room offers fewer distractions which allow the student to be more focused on the teacher.

This research would indicate that a student's performance in the classroom is not based solely on their natural academic ability. Rather, their environment plays at least some part in their success or failure of a subject.

Classroom ecology

The physical arrangement of most classrooms reveals much about the learning process. From lecture halls, to smaller and more personal classrooms, they all look relatively the same. A series of desks or chairs neatly organized with a desk or podium at the front. It does not take much imagination to picture students filing in,

sitting down, opening notebooks and sitting mute during the class hour while the instructor stands behind his podium or paces in front of the room. Sanders (1958) found teachers and administrators often did not take advantage of innovative furniture arrangements. Even if portable chairs were used, they rarely moved from the fixed rows that students and teachers alike were accustomed to. "The sanctity with which straight rows are regarded makes it almost inevitable that departures from them will be considered subversive" (Becker, 1973, p.515). Even when Rolfe (1961) compared participation in classrooms which had either stationary or moveable seating, he found that the moveable seating, despite it being easier and more convenient to teach, yielded a pattern of teaching and use of space that changed very little.

Virtually all experimental classroom designs have occurred at the elementary level (Becker, 1973). When a person walks into a classroom today, they are reminded of the traditional schools of old. On the contrary, there are a number of advocates for different shaped seating arrangements, such as the horseshoe or circular arrangements. In addition to the arrangements undergoing change, the furniture itself is under modification. A company named the 101 Group is developing furniture that takes on multiple tasks. The idea, according to president and owner Burnett Nelson is "to design the classroom of the future--a classroom that will allow the teacher or the instructor to be a facilitator instead of a lecturer. That means the furniture is moveable and has many functions" (Gite, 1998, p.1). Nelson's firm designs and manufactures tables with tops that are reversible, one side being magnetic and one having Legos®.

The market for these products indicates that educators are interested in the environment in which our students are learning, not just the content.

Although the primary focus of the literature is on seating arrangements, it is imperative to at least mention other factors of classroom ecology. It is critical for the reader to understand that seating arrangements alone cannot be the only variable that is changed for complete success in the classroom. In order to identify the factors and circumstances under which students learn, Dunn and Dunn (1972) developed the Learning Style Inventory (LSI) with twelve variables. It was revised in 1998, and now has twenty-two variables in four categories found in Table 1.

Table 1

Categories and examples of the Learning Style Inventory (LSI)

Category	Variables	Category	Variables
Environment	<ul style="list-style-type: none"> • Sound • Temperature • Seating design • Lighting 	Emotionability	<ul style="list-style-type: none"> • Motivation • Responsibility • Persistence • Need for either structure or flexibility
Sociological Needs	<ul style="list-style-type: none"> • Learning alone or with peers • Learning in several different ways • Need for presence of authority figures • Parent/Teacher motivation 	Physical Needs	<ul style="list-style-type: none"> • Auditory/Visual/Tactile/Kinesthetic preference • Learning in the day or evening • Intake of food or drink • Mobility

Typically, six to eight LSI elements affect the individual during the learning process when students are faced with new or difficult material (Rayneri, Gerber and

Wiley, 2003). Classroom teachers who are presenting difficult or challenging material must address these issues, or expect to have limited success with the material.

Baum, Renzulli and Hebert (1995) suggested that underachievement can be linked to a mismatch between the learning styles of students and the instruction used in the classroom. Dunn and Dunn (1993) hypothesized that the interaction of various environmental factors affects each person differently as he or she learns. Several studies have suggested that underachieving students make significant gains in classroom performance when their learning style preferences are accommodated (Andrews, 1990). Restak (1979) found that 60% of one's learning style is a biological and developmental set of characteristics. This can result in effective instruction for some students, but ineffective instruction for those whose learning styles do not match their school environment (Dunn and Dunn, 1990).

So with various learning styles in the classroom, how do teachers set up a classroom ecology that works for most students? Carbo and Hodges (1988) found that "at risk" students tend to have a higher preference for tactile and kinesthetic activities, mobility and eating or drinking while learning. They are global/right brain learners, who are also most alert and learn best during the late morning or early afternoon hours. They prefer noise in their environment, highly structured assignments and visual learning. This is in partial contrast to intrinsically motivated students, who prefer to work alone, have higher motivation and are more persistent than their peers. These students also liked low levels of noise and unstructured assignments. Similarities do, however exist. Both motivated and "at risk" students like to learn

through tactile modalities, prefer dim lighting, informal seating design and warm temperatures (Rayneri, Gerber and Wiley, 2003). These similarities are where it would be beneficial to start a classroom and then tailor the more specific needs based on the type of student one is teaching.

Student misbehaviors

The ideal classroom is one where there are minimal distractions to learning, focused attention on classroom discussions and positive learning about critical subject material. With this in mind, it is important to understand what causes misbehavior and what can be done to limit it. For the purposes of this study, particular attention will be given to the effect seating arrangements have on misbehaviors. Misbehavior must be taken in context however, since one must look at the situation and instructor to determine if a particular action falls in the misbehavior category. For example, walking around during a math lesson would be unacceptable, but walking around in a pottery class would be expected (Burden, 1995).

In one study by Türknüklü & Galton (2001), Turkish and English classrooms were examined in order to identify misbehaviors based on various characteristics. They differed in their seating arrangements in that the Turkish classroom was set up more like a traditional American classroom with rows and aisles. The majority of the English classrooms were composed of students sitting in groups around tables. It was found that the percentage of “noisy or illicit talking” (Türknüklü & Galton, 2001, p.300) and “interrupting other pupils” (Türknüklü & Galton, 2001, p.300) was greater in the Turkish (row and aisle) setting than the English (group) setting. However, it

was interesting to note that the group arrangements were rarely observed as working in groups. As a result, different types of misbehaviors arose. The two most commonly observed in the group setting were “inappropriate use of materials” (Türknüklü & Galton, 2001, p.300) and “inappropriate movement” (Türknüklü & Galton, 2001, p.300). Lastly, the Turkish teachers found that their orientation of seats lent itself to a location problem. They found that there was a relationship between sitting in the back or sides of the classroom and the number of misbehaviors a student demonstrated. Students who sit at the back of the classroom had less interest in the lesson and created a major problem for the teachers.

Student preferences for seating

Research indicates that there are differences between students who sit in the front of classrooms and students sitting elsewhere. “Seating preference depends on the interest level students have in the subject matter. If students are interested in the course, they tend to sit closer to the front of the room, and if they are not interested, they tend to sit towards the back” (Kaufman, 2005, p.1).

In their study of seat choice and personality, Totusek and Staton-Spicer (1982) tested two hypothesis: (1) students who voluntarily chose to sit in the seats located in the front and center have different personality characteristics than students who chose to sit elsewhere, and (2) when students are assigned seats, the students in the front and center seats have different personality traits than students sitting in other parts of the room. Their research concluded that in both cases, whether assigned or

self-selected, students who sit front and center were generally more assertive, more imaginative and more self reliant.

Wulf (1977) compared two classrooms, taught by the same professor, same course, consecutive semesters and same rooms. One classroom was assigned seating, and the other was student selected. Her research also indicated that the higher performing students were found in the front of the classroom, whether self selected or assigned. A later study by Holliman and Anderson (1986) concluded the same when they examined two introductory psychology classes under similar conditions. They found “students seated in the center of the room scored higher on exams than those seated towards the sides” (Holliman and Anderson, 1986, p.200). This research suggests that sitting in the front of the room, regardless of student preference, will generally have a positive effect on their course grade. However, it also suggests that moving students who would normally sit in the front to a side or back seat can also have a negative effect on their course grade. Care must be taken to avoid hurting the motivated students with the intention of helping the unmotivated.

Alternative seating arrangements

Although in theory, countless types of seating arrangements can be used in a classroom setting, four of the most popular types are: row, herringbone, U-shaped and group. It was found that each style had certain qualities which made it more or less desirable in a particular setting. For clarification, the four types of arrangements are diagrammed in figures 1-4.

Figure 1. Row Arrangement.

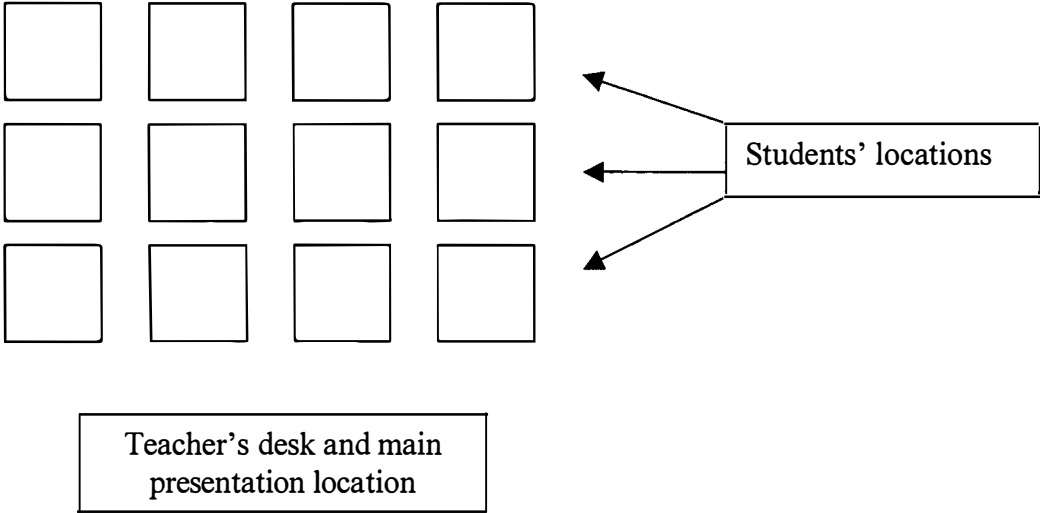


Figure 2. Herringbone or split half arrangement.

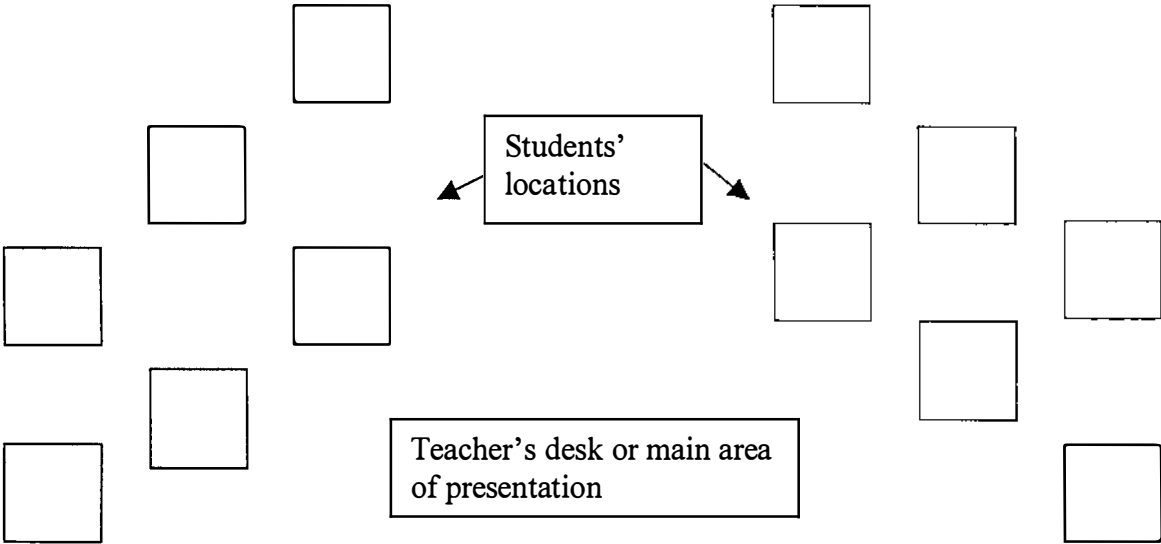


Figure 3. U-shaped arrangement.

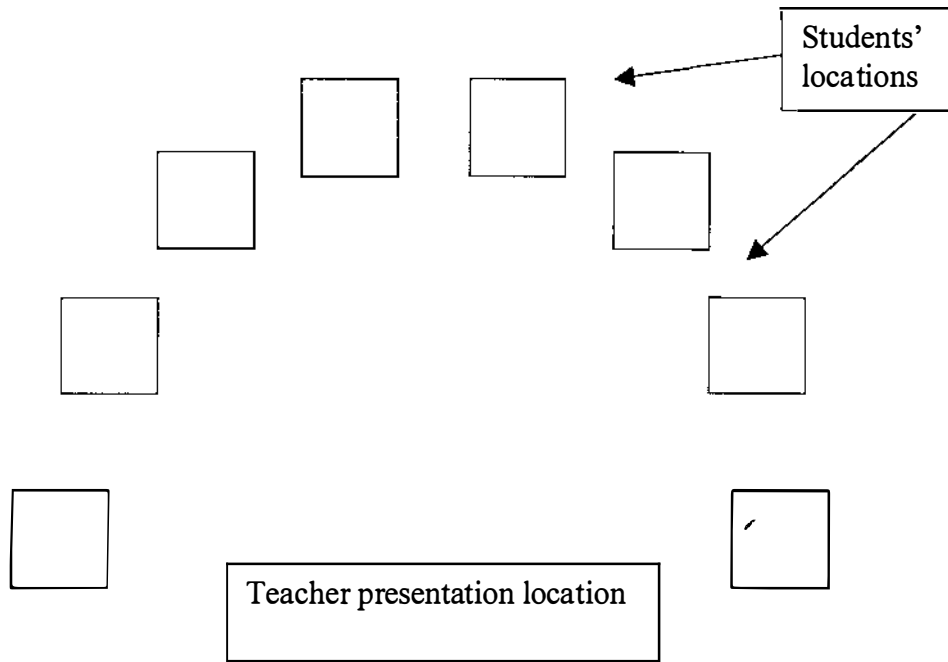
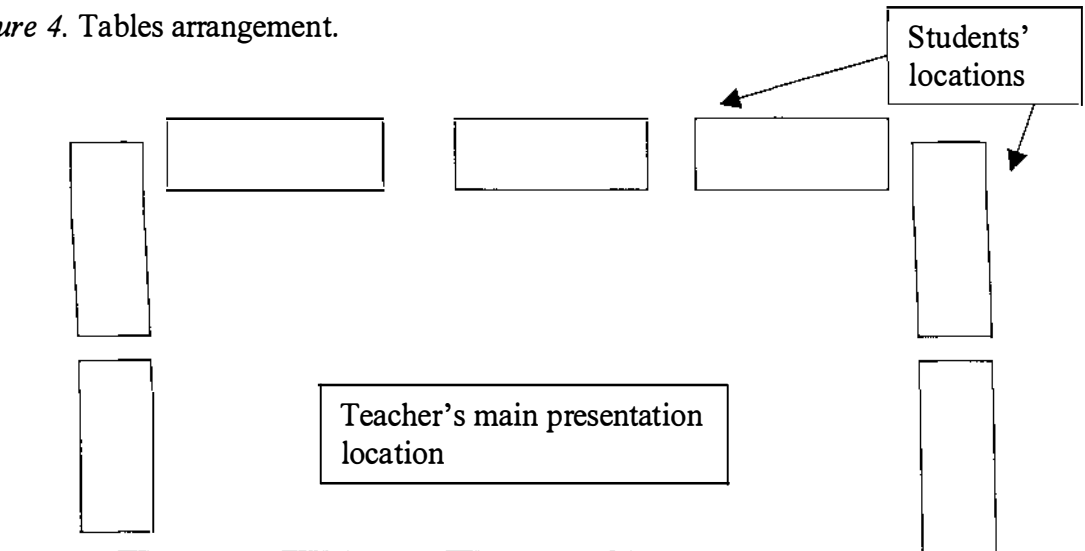


Figure 4. Tables arrangement.



Note. Figure 4 represents one possible way of arranging tables in a classroom. Other variations are possible.

Ridling (1994) noted many interesting observations of the various arrangements of students. There was evidence that interactive teacher talk behaviors increased and were affected by seating arrangement. Most of the time, herringbone and U-shaped arrangements tended to have the same effect. In both cases, when desks were arranged in either the herringbone (also referred to as “split-half”) or U-shaped, there was greater interaction between the teacher and the students and between the students themselves. These results suggest that seating arrangement influences participation, thinking and appropriate comments which in turn can have a positive effect on learning. This type of interaction also seemed to enable teachers to use the behaviors in ways that made their lesson presentation more active and collaborative among students. The U-shaped arrangement also allowed for easier classroom discussion, student presentations and role playing activities (Bonus, Riordan, 1998). The results however need to be coupled with the teaching style. It was found that teachers who prefer herringbone and U-shaped arrangements were the same teachers that have a higher tendency towards indirect teacher talk behaviors. A classroom where debates are possible and interaction is encouraged would benefit from these arrangements. The teachers who were found using the row arrangements preferred direct teacher talk behaviors, such as lecturing and giving directions. This type of instruction however is certainly influenced by the lesson content being presented. The difference between a high school debate class and a math lesson will present two different needs for instruction. “Teachers in the U-shaped or split half seating arrangements lectured in significantly fewer frequencies than in row seating”

(Ridling, 1994, p.7). So it seems that certain arrangements lend themselves more easily in certain situations than others, depending on the style of the teacher and the goals of the classroom.

Rose (1998) suggests that teachers could also consider changing classroom arrangements to meet specific needs of the lesson. For example, if a particular lesson was on biofuels, and students were to debate the advantages and disadvantages of E85, a different classroom arrangement that lent itself more favorable to discussions could be employed. This type of thinking allows the classroom to become more active in helping students learn. Instead of the classroom being an obstacle, it can be a tool to facilitate certain goals of the teacher. It is important to note that while certain arrangements tend to have greater dispositions to various types of teacher student interaction, an important role is also played by the nature of the students, enthusiasm of the teacher, subject material, lesson content and other factors than solely the arrangement of seats.

Group arrangements can also be found in many American classrooms where students sit in tables of four to seven pupils per table. Much of the research concerning groups originates from England where group arrangements are common, especially at the primary level (Bealing, 1972). One study by Hastings & Schwieso (1995) looked at the effect of groups versus rows, specifically the time on task for each arrangement. The on task rates were substantially higher when children sat in rows. Class A's mean on task level during the Phase 1 rows condition was 75 percent. On moving to a group arrangement in Phase 2, mean task level fell to 56 percent.

Returning to rows for Phase 3, the mean on task level rose again to 79 percent.

Researchers went on to support their findings with a second group, Class B. Class B's mean level was 66 percent during the Phase 1 groups condition. In the rows arrangement in Phase 2 it rose to 76 percent. Returning to groups for Phase 3, the mean on task time level declined to 65 percent. Interesting to note, the findings also eliminate the connection between whether the students were *initially* setup in rows or groups, since both classes had the same effect.

Groups can be beneficial if used in the right context. Bonus and Riordan (1998) noted that group work was advantageous because groups were already formed. Also, students were able to easily assist one another when a question arose during work time.

Looking more specifically at the individual's response to moving from rows to groups, Wheldall (1981) found that the most affected students were children who were least on task in a groups arrangement. In a second study, with three children who were proving themselves very difficult to control and making very little academic progress, the researchers again put students into a rows configuration. Not only did the whole class increase their time on task, but the disruptiveness of the three problem children decreased dramatically (Hastings & Schwieso, 1995).

Research indicates that both tables and rows have advantages. Tables allow students to work with each other and benefit from group learning. Rows of individual chairs allows for more focused individual work time with minimal distractions. One suggestion by Hawkins (1997) is to have desks that interlock to form tables, thus

allowing a quick switch between the two formats to customize learning. Stackable chairs would allow for clearing of additional room should the lesson demand it.

Research suggests that the front of the classroom *is* the best place for highest performance. However, it is a bit more complex than just that. Sitting in the front of the classroom is determined by the number of students present, so in many cases, classroom size creates issues. It has been shown that classroom size has a direct effect on the amount of student participation, with smaller classes (6-20 students) having nearly twice the amount of student participation compared to medium (21-50) and large (50+) student classrooms. Smaller classrooms had an average of 5.8 minutes of student participation, while medium and larger classrooms had 2.4 and 2.6 minutes, respectively (Becker, 1973). Higher student participation naturally falls in line with better student performance of, since more communication allows the teacher to address issues that arise, understand more clearly where the students struggle, and keep the energy and motivation of the students high. Sommer (1967) also demonstrated that students who sat in front and who had visual access to the instructor participated more than students at the rear or sides of the room. Interestingly, even though the length of time spent interacting was increased in a smaller setting, the actual number of students participating remained approximately the same, about seven students in each classroom setting (Becker, 1973). However, comparing the percentages of participating students, the smaller classes were far ahead with an average of 41% compared to 19% and 7% for the medium and large classes, respectively.

“Grades decrease as a function of distance away from the instructor both towards the rear and side areas of the room, although distance toward the rear was more pronounced” (Becker, 1973, p.522). This statement sums up the first question. Students *do* seem to do better when they are sitting closer to the instructor. This is probably a result of a student’s increased class participation, instructor proximity, increased eye contact, and fewer students offering distractions.

Students will also increase performance when they are moved to the front, even if their seat preference is in the rear of the classroom (Benedict and Hoag, 2004). It was found that a student who preferred the rear, but was brought to a center row, reduced the average probability of receiving a D or F from twenty-three to twelve percent, an eleven percent net gain. They also were found to have a 40% higher chance of receiving an A. Not surprisingly, the opposite effect happened when students were moved from the middle aisle seats to side seats (Benedict and Hoag, 2004). This suggests that a teacher can improve students’ grades by bringing them to the front or to the center. However, this must be done with caution. The teacher can also negatively affect a student’s grade by placing them in the back or to the sides of the room.

When the students are sitting in lecture (rows), they have fewer interactions with others students and the teacher. While this includes a lowered amount of interaction with the teacher, it also includes a lower amount of interaction with fellow students. Of all the seating arrangements, rows offer the lowest amount of interaction.

Herringbone, U-shaped and group arrangements of students offer more

student interactions, both with each other and with the teacher. These interactions would be advantageous during a time when students are expected to discuss, debate, argue or question. English, Politics, Social Studies classes would benefit since they are the type of classroom when there is more discussion over events than presentation of facts. Consequently, the teacher then can also be allowed to walk around and deal with individual problems as they arise. The problem however, is that with increased student interaction comes increased propensity to get sidetracked. The students might find it more enjoyable to engage in conversation pertaining to outside activities, such as the latest video game or movie instead of talking about the problem at hand. Since the level of interaction is high, the teacher might not discover that students are not on task until several minutes pass and one or two groups are lagging behind.

Another consideration would be a student with special needs such as Asperger's syndrome. That particular student would benefit from sitting next to a student who could act as a helper for the Asperger's student (Safran, 2002). In this sense, communication would be encouraged, since the Asperger's student would benefit from having the companionship and help from a fellow student, and the student in turn would get to teach the Asperger's student. This would enable greater comprehension for both students and thus be beneficial to them and the teacher.

Placing students with ADD or ADHD at the periphery of the classroom would help them by allowing the teacher or helper to have more interaction with them compared to if they were placed in the center of the classroom. A teacher would be

less intrusive to the rest of the class if they were to help a student off to the side rather than in the center of the room (Brown, Ilderton and Taylor, 2001).

Lastly, some teachers work with students who are “at risk”. These students need a classroom that is warm, orderly and neat. The hanging of positive posters, student’s work and the presence of plants in the room make for an encouraging and welcoming environment for these students. In order to make the teacher a less authoritarian figure, the teacher’s desk should be placed at an angle, instead of perpendicular to the students (Botwinik, 1997). Botwinik (1997) also suggests putting a full length mirror in the classroom to allow students to walk by and give themselves a quick evaluation to make sure they are doing well, both physically and emotionally.

In conclusion, research has indicated that a student’s environment is an active part of their learning. This contradicts views that believe the classroom is just a means to an end. Instead, the classroom is an important factor in a child’s education. Understanding how an environment affects students can help teachers foster a comfortable and supportive environment for the success of their students.

Chapter 3: Applications and Evaluation

Introduction

Literature studies have shown that a child's educational environment will influence many things in the classroom. I chose to focus on two such variables, academic performance and behavior. Research has shown that a student's position in the classroom can change their performance on assessments and overall retention of material. Studies have also indicated that children will exhibit fewer behavior problems if arranged in a particular fashion. My study looks to explore these two consequences of student arrangement, to see if there was a pattern that existed within my class, and to use this pattern to improve education for all my students.

Instruments of Study

In order to perform research that would give me a clear picture of my classroom, I developed quantitative and qualitative instruments to judge how students were performing in my class. Students received a three part questionnaire at the conclusion of every class that presented new information.

The questionnaire consisted of three questions related to the day's lesson. The first question was a simple recall question, which would be asking a fact learned from the day such as "What does the atomic number represent?" These questions would generally be one of the objectives of the day, so they would indicate to me if the student understood a primary goal for the lesson. The level of this task would be the first on Bloom's taxonomy—Knowledge.

The second question would be a more detailed question that would require knowledge of several facts presented in the lesson which the student would have to combine to form an answer. A typical question would read something like “How does one go about calculating the number of neutrons in an atom’s nucleus?” These questions would be more of a synthesized answer to test the student’s relational knowledge. In other words, how well can the student take two separate pieces of information, understand their relationship and answer a question based on that relationship? This task would be equivalent to the second level of Bloom’s Taxonomy—Comprehension.

The third question would be an application question. This would involve the student completely synthesizing an answer to apply the knowledge to an unknown problem, or make a connection to an outside event or example. A typical example would be “Electrochemistry—also known as redox—can be found in many places in and outside of the classroom. What is one specific example where electrochemistry can be used outside the classroom?” The goal of these questions would be to use what was given to them in the form of direct or constructive instruction, and synthesize or connect it to an outside event or phenomenon. This utilizes Bloom’s third level—Application, and in some cases the fifth level—Synthesis.

In addition, classroom observations of management issues, general thoughts on how I thought the classroom went and notes of how actively the students were engaged in the learning were collected. Actions such as eye contact, discussion with other peers, participation in class discussions and hand-raising were all indicative of

high engagement learning. Actions such as apparent daydreaming, looking out the window, sleeping, talking with other students at inappropriate times and lack of eye contact were indicative of low engagement learning. These observations were recorded as daily journal entries.

The study was conducted over a 15 day period during the spring of 2006 in a suburban Western New York high school. Since the study was designed to test recollection and application of new material, the study did not include the closing weeks of the academic year since this time period was set aside for strictly reviewing previously learned material.

At two separate times during the course of the study students were assigned seats randomly, once at the beginning of the study and once at the midpoint. The teacher assigned each person a number from one to the maximum number of students in the classroom. Then a web based random number generator was used to assign seats. The student with the first number would sit in the extreme front/right hand side of the classroom, the next person in the next seat and so on. Randomization minimized the occurrence of “cliques”, although in some instances, friends still found themselves in the general proximity of some of their peers.

Participants

Three Regents Chemistry classes were observed, seventy-eight students total. Four levels of chemistry are offered; local, Regents, honors and Advanced Placement (AP). Many students choose chemistry because of the third year science requirement that is currently in place. A host of other science courses besides chemistry are

available, such as anatomy and physiology, astronomy, forensics and environmental science. Many of these courses suffice as a student's third year science and generally accept the weaker science students since these courses are not comprised of highly demanding material. The students in the study are considered to be above average in maturation and motivation for their grade.

Procedures of Study

The classes were taught in a "normal" instructional format; twenty to thirty minute lecture, thirty to forty minutes of classwork time on newly acquired material and ten to twenty minutes of review time. At the conclusion of each class period a questionnaire was administered to the students.

In addition to asking these three questions, the students were also asked to mark their location in the classroom. Key indicators were placed on the diagram to give students a reference point. The indicators included the teacher's desk and the front door. Students were instructed to place an "X" in the seat that indicated their location within the classroom on that particular day. Although the diagram was not to scale, it did contain the correct number and positions of the key indicators and students' desks. The diagram was arranged in such a way so that when a student looked at the diagram, it was easy to determine their location. The teacher's desk was at the front of the room, thus it was at the top of the diagram. Even with these precautions and instructions the possibility that a student incorrectly marked his/her location within the classroom, which could alter the results, still remained.

The students were continually reminded to keep the questionnaires anonymous. Anonymity was important for two reasons. First, it adjusted for teacher bias. For example, if a student's name was on a paper, emotional responses could come become a factor, positively or negatively. A positive response may result in the teacher's leniency of a student response. A response to a question such as "What does the atomic number represent?" could yield the answer "protons." If given a favorable emotional tie to the student, that student may receive credit for a correct response as a result of teacher bias. A negative emotion tied to that student could have the opposite effect. The student could be marked incorrect on the grounds that they did not say what about the protons it represents. The correct answer would be the *number* of protons, but a student who does not specify could also mean the weight of the protons or the charge of the protons. With no knowledge of the student, thus no emotional connection to the answer, neutral grading can be accomplished. The second reason for student anonymity was just that. Although I was the only person to look at the questionnaires, I felt it was necessary to protect student identity according to the approved IRB proposal.

Unfortunately, anonymity led to unforeseen consequences. First, a student who does not put their name on a paper generally assumes less accountability for their responses. I noticed this while grading questionnaires. A few students responded with what I considered to be "smart-alec" or nonsensical answers presumably because of the anonymity.

Lack of accountability also led to a lack of effort. A student who knew that the assignment was not going to be graded was more likely to put less effort towards it than if it had been. I could not grade the papers, since I did not know the student's identity. The lack of effort could give inconsistent results for a particular section of the classroom.

Lastly, the activity took time. On occasion, some classes ran long because of extra questions and minor problems. This normally was not a problem, as a small amount of extra time was built into the schedule. However, when that time had expired, the students found themselves with a very short amount of time to complete the questionnaires, rushing to get them complete. This rushing, coupled with a lack of accountability could have led some students to give a misrepresentation of their knowledge of the subject material.

In spite of these consequences, the observations I made while distributing the questionnaires were generally good. I felt that students were taking them seriously, and giving them an honest effort. Although it was expected that a few people would take advantage of the free time and put nonsensical answers, the overwhelming majority, from what I observed, treated the questionnaires with sincerity and put forth good effort.

The other method I used to conduct my research was a more subjective approach. I kept a small journal in my desk, and at the conclusion of every day, I would write some observations about the day. These observations were generally a feeling that I got after the day had concluded. I tried as hard as I could to separate the

thoughts into the separate classrooms, which generally was not a problem. By this time during the school year, each class developed a “personality” that was easily remembered. Since I only had two to three classes a day, it was easy to keep the classes straight in terms of major issues, and general feelings. It was impractical to write a response immediately following each class, since in most cases another class was entering the room. The time required to write a reflective entry in my journal was simply not afforded at that moment. Duties such as taking attendance, resetting experiments, cleaning overheads and many other things pressed my time such that a journal entry was not possible. In addition, if I had scribbled something down, it would not be to the introspective level I wanted. For these reasons, I left my entries to the end of the day so I could reflect on my feelings throughout the day and document them accurately. These feelings were based upon several factors that included problems encountered by students, behavior issues, questions asked by students, time on task and side discussions between students.

These observations allowed me to catalog my thoughts of the day and give a more personal response to how I felt the day had gone. I felt they complimented my research and gave me two angles of approach. The first angle was a numerical conclusion, based off simply a “yes” or “no” type of evaluation. The student either got the question(s) right, or they got them wrong. While valuable in its own right, looking strictly at this objective answer would have been short sighted. The nature of the classroom, the camaraderie, the rapport between the students and me would have been lost in the numbers. Were the students easier to teach? Did they seem to enjoy

the subject, and ask interesting and provocative questions? Were there significant behavior issues? These questions were not able to be answered simply by looking at if they correctly answered questions. They were answered in my journal entries.

It is important to note that my journal entries were not reviewed by anyone and therefore bring an obvious bias. While I tried to be as honest as I could, I wrote from my perspective, not taking into account administrators, parents, students or other teachers' points of view. I felt I was honest in my journal opinions, and derived conclusions that were real and unbiased. In addition, to ask other's opinions, whether they be administrators, students or other teachers would have been challenging. Outside adults might have perceived my humor as not being funny, or my rapport with my students not being visible. It would have been difficult, if not impossible for other teachers to tell me how I felt about my classroom. Asking students would have brought on a whole different set of opinions. Their idea of fun and productivity vary widely from student to student, and in many cases, from teacher to student. A question such as "Did you have fun today in chemistry class" would have received varied responses if the entire period was spent learning about a challenging topic. Students who enjoy challenges would have given a positive response, while less motivated students would have given a negative response. It would have been difficult to qualify the answers as well, since the students have biases as well. Some students love science and others despise it. It was for these reasons that the students were not asked their opinion on the class. I felt that my journal entries were the only way to keep conclusions fair.

Chapter 4: Analysis

Quantitative Analysis

The results of the surveys revealed many key findings. I believe they can be implemented to result in improved classroom performance. Throughout this three week study, I collected a total of 308 surveys across twenty-five seats in the classroom. This averages out to 12 surveys per seat. It is important to note that on days when I administered tests and labs, which took the entire period, I did not distribute surveys. Also, because of our rotating schedule, I taught students only three out of four days.

At the end of the school year, I graded the surveys in a single session. I marked the questions either correct or incorrect and I gave no partial credit. Once completed, I arranged the surveys first by row, then by seat. I further broke them down by question. Since my class sizes varied and absences were frequent – about two to five per day – I computed all the results by percentages. Table 2 displays my data for first, second and third questions, and then a total percentage across all questions.

I conducted my surveys using a traditional physical classroom layout. The teacher's desk is located in the front of the room, and most teaching is done from there. I presented the new information in a lecture format from the front of the room utilizing an overhead projector. To the students' left is a wall with posters and the homework board, and there is a door at the front. To the students' right is a row of windows with a bench in between. The average distance between the rows is

approximately two feet, which tends to push students together more than in some other classrooms I have seen.

Behind the students sits a laboratory area that is in full view of the seating area. The lab features a large interconnected table where students and the instructor can work with gas jets, water and electric facilities. The students in the last row of desks are situated about six to ten feet in front of this table facing the front of the classroom. The results are tabulated in Table 2.

Table 2

Results from Action Research

	<u>Row 1</u>	<u>Row 2</u>	<u>Row 3</u>	<u>Row 4</u>	<u>Row 5</u>
Seat 1					
Question 1	86.7	100	100	93.8	77.8
Question 2	80.0	85.7	100	81.3	44.4
Question 3	100	92.9	85.7	93.8	55.6
Total	88.9	92.9	95.2	89.6	59.3
Seat 2					
Question 1	60.0	92.9	92.3	86.7	80.0
Question 2	90.0	100	84.6	80.0	50.0
Question 3	80.0	100	100	100	80.0
Total	76.7	97.6	92.3	88.9	70.0
Seat 3					
Question 1	75.0	84.6	100	85.7	87.5
Question 2	50.0	92.3	80.0	85.7	100
Question 3	100	84.6	93.3	92.9	87.5
Total	75.0	87.2	91.1	88.1	91.7
Seat 4					
Question 1	85.7	64.3	87.5	100	100
Question 2	28.6	35.7	78.6	60.0	71.4
Question 3	57.1	64.3	85.7	100	92.9
Total	57.1	54.8	88.3	86.7	88.1
Seat 5					
Question 1	100	87.5	90.9	82.4	93.8
Question 2	76.9	62.5	90.9	70.6	87.5
Question 3	84.6	62.5	90.9	94.1	87.5
Total	87.2	70.8	90.9	82.6	89.6

Note. All results are in percentages.

When I started tabulating the results, some trends became very noticeable. The first trend I noticed seemed to answer my original question. As one proceeds from the front of the room to the back of the room, the total percentage of questions answered correctly decreased. Specifically, in four of the five rows, the total percent of correct answers decreases as the proximity to the teacher increases. A possible reason for this finding could be due to the increased space between the teacher and student, more distractions in front of students, difficulty seeing notes, and easier chances to converse with other students. Unfortunately, due to the nature of the classroom arrangement, it would be difficult to minimize these distractions. Due to the narrowness of the classroom, it would be difficult to consider a herringbone or U-shaped arrangement of desks. The current arrangement has people sitting in front of other people, which will inevitably lead to distractions.

The increased distance from the teacher could also facilitate more conversations between students, either verbal or written. These conversations would be difficult for a teacher to stop since they take place at a greater distance from the teacher and to the rear of many students, which hinders visual recognition of these acts. It was significant to observe in the data that student performance decreased as the distance from the instructor increased. The students at the very rear of the classroom generally showed lower scores than those seated toward the front. This finding seems to indicate that better learning occurs toward the front and center of the room than toward the rear and sides.

The second trend noticed was the one with row five—the row closest to the windows. Oddly enough, this row exhibited a random trend. The numbers increased towards the middle and then decreased towards the back, making it difficult to consider a solid reason and leading more to speculation. It is possible that the students that were randomly assigned to sit in those seats were some of the lowest performing students in the classroom, and thus their performance on the surveys dropped the average for those particular locations. The sample size was small enough that one or two severely underperforming students could have a significantly negative effect on the results. However, this would be easier to justify if there were one or two seats that were out of order, either over or under what they were “supposed” to be. As one can see with row five, the whole set of data was skewed, showing no trend in any direction. This leads me to think that another explanation is in order.

The row is situated along the windows, which face the courtyard. This survey was completed in May, which means the windows were likely open and the courtyard in bloom. I conducted the surveys during normal school hours and early in the morning as the sun rose. Thus, all classes had the opportunity to look outside. My hypothesis is that sitting close to the windows may decrease performance in the classroom. I believe the extra distraction of activity in the courtyard and possible noises from outside contributed to neglecting the material at hand and poorer performance overall.

Also significant, the design of the classroom places an air circulator next to the first two students. This unit is physically as high as the window sill, not

obstructing any view. A lab desk next to the back three students is higher, coming eight to ten inches above the base of window. This desk obstructs the view and makes it more difficult for students to look out of the window as they are seated at their desks. This window location seems to give students yet another distraction possibility on top of all other distractions that are present in the classroom. It is possible that these two object-related physical features correlated to the two low scores in seat one and two of row five. The rest of row five looked to be in line with the other rows.

My third observation was an unusual spike in performance in the rear of the classroom. Interestingly, the last seat in four out of five rows rose in total performance compared to the seat in front of it. This observation is contrary to the trend I observed in the first four seats in most of the room. I found this to be unique as the rest of the results suggest that students in the back section of the room should score lowest. One possible explanation is the increased amount of space in the back of the room. This could have given students a more comfortable approach to the class, improving their performance. Also, without students behind them, they could have felt less “boxed in” and more relaxed to listen to the teacher. It might have been this comfort factor that allowed students to do well when placed in the back of the room. It is possible, however, that students could have cheated on the surveys, and being in the far back minimized the likelihood of this improper behavior being observed.

My last observation concerns the lack of a large discrepancy between the average results for the first, second and third questions. They were 87.7%, 74.7% and 86.6% respectively. In general, the second question proved most difficult for most

students, while the application question was on par with the simple recall. I was encouraged to see this since students seemed to be learning both facts and applications during the instruction. The detailed recall seemed to challenge students across the entire sample. However, although the average second question results were lower, there was not a particular area of the classroom that yielded specifically lower results. In fact, the questions missed in all areas of the class were fairly randomly dispersed between all three types of questions. It is interesting to note that even though the type of questions students missed exhibited no real trend, the total percentages did exhibit noticeable trends.

Qualitative Analysis

The second part of the evaluation was more subjectively based. They were my daily journal entries about the effectiveness of my new arrangements. I wrote these in a small pad of paper at the conclusion of each day. There were a total of ten entries. I made entries only on days when I presented new material, not on lab or test days when the seating arrangement were different, allowing students to work with partners and in close proximity. This part of the classroom experience was usually not regulated, and students were allowed to work with whomever they felt comfortable. Since the lab was not related to the study, I recorded no journal entries.

In addition, I administered one test during the course of the study. This too had no journal entry recorded for it. My students, no matter where they were sitting, were well behaved during the test and since I presented no new material, no journal entry was necessary.

I did not use the test grades in this study for two reasons. First, the unit being tested started before the study began. Second, during the final week, I instituted the new seating arrangements. Therefore, to have included these results in the study would have introduced inconsistency.

The results from my journal entries were mixed. In the beginning, two of my three classes showed improvement in scores under the new seating arrangement. Students were quiet, and I found they paid attention. My other class showed little to no improvement. This was a larger class and probably the worst behaving class I have ever had. No matter how I arranged the seating, certain difficult-to-manage students wound up sitting next to or near each other. The students would talk out-of-turn, throw things, comment inappropriately and act defiantly and then protest innocence when asked to stop their behavior. In my career, I have never had a lower performing class.

While the randomness of rearranging the seats worked to break up some cliques, new ones formed. Unfortunately, there were three instances when the seating arrangement backfired completely. Two students whom I had previously separated were now back together. This was very difficult to control, but for the sake of the experiment, I chose not to move those students to other areas. Since I used random arrangements, I was unaware of any potential problem until I sat students in their seats. I would have introduced bias to go back and rearrange after that.

Overall, the rearrangement worked for some students and some situations, but not for others. In a few instances, students were separated from others but placed next

to students who still created problems. It seemed to work for short amounts of time, but students started making friends (and thus talking to them) very quickly. A better approach would have been to personalize the seating arrangement to avoid problems like this, but for the integrity of the experiment I maintained my random assignments.

Chapter 5: Conclusions and Recommendations

Discussion

Overall I was pleased with the results of the experiment. The results supported the hypothesis that sitting the front and center of a classroom will have a positive effect on a student's retention of material taught. This will, in turn, result in better performance on questions directly related to the presentation and questions that involve application of the material. This information can be useful in a number of ways.

First, the location in a classroom can be used to a teacher's advantage. For a student who is struggling, relocating them to the front or middle of the room has a positive effect on their grade. However, this must be done with caution because moving students can have both positive and negative effects. If through moving the teacher has put two students next to each other who are mutually distractive, then the move would be counterproductive. Careful observation must be made to look at students' peripheral neighbors to make sure they are not being placed next to students who offer distractions. A teacher who keeps these guidelines in mind can effectively help students who are struggling with material by bringing him or her forward to affect their attention potential. The results of both my research and my experiments prove that students who are sitting front and center can perform better on newly learned material.

There is an inherent danger however. To place a student in a particular location displaces another student. In other words, somebody has to sit in back.

Research shows that this is a place in the classroom where distractions are prevalent and performance is diminished. Placing students in the back seems to have the opposite effect of placing them up front.

Action Plan

So what to do? My suggestion is to rotate students frequently. By bringing students up front, even for a short time, the student has the potential for higher grades and more teacher interaction, therefore helping to increase intrinsic motivation. This motivation could be brought to other parts of the classroom, so the student is not required to sit in the front in order to do well. Conversely, placing a high performing student in the back of the room for a short period of time could limit any potentially negative effect on their grade. Moving students in a regular rotation is likely to help stronger students by keeping them out of the poorer producing sections of the room, and help weaker students by moving them to higher performing sections. Such movement could also prevent the formation of student cliques, which are often counterproductive to good performance.

As with any plan, I see downsides to the movement. First, it is a time consuming task to plan consistent movement. Planning a seating chart every couple of weeks can become a significant task, especially when teaching three or more classes. Second, students who prefer structure in the classroom could have a very difficult time regularly changing their seating. As soon as they become accustomed to one seat, they would need to change seats again. Third, every movement of the

classroom takes time for the students to become comfortable with their location. This adjustment time potentially takes away from class instruction.

Another alternative would be to have certain “hot seats” in the classroom that the teacher reserves for designated students. For example, students could be assigned seats at the beginning of the class, while certain seats are left unoccupied.

Unbeknownst to the students, those are the “hot seats” that the teacher has reserved.

When students are in need of some extra help, these reserved seats can be utilized for that purpose. Since at the beginning of the class the designated students would not be identified, the ‘hot seats’ would be available for use when the time comes.

Yet another plan would be to have students involved in a constant rotating arrangement. For example, one week everyone sits in their assigned seats, and the next week everyone moves up one seat. The student in the front moves to the back to begin the new arrangement. This would help since students would be generally around the same people. Transition time would be minimal, and the neighbors would stay fairly consistent. The students who like structure would be able to move in a predictable pattern, minimizing the conflict and necessary adjustment time.

With the exception of the last plan, all plans would involve the teacher’s observation of students who are in need of help. Care would have to be taken not to interfere with the needs of Special Education students, or students who have hearing or visual problems. These students would have permanent seats, and others would rotate around them. Although this might make the student feel uncomfortable, the needs of their IEP must take precedence.

The teacher must be responsible for notifying parents if individuals are being moved in an effort to help their grade. This could be done by telephone or through a parent-teacher conference. The date of the switch would be recorded and the results monitored to see if the student improves. Counselors and administrators would also be involved.

Recommendations for Future Research

Although I am pleased with the results of my research, I would have preferred a longer, more detailed experiment. My experiment was limited to a few weeks and fewer than 100 students. Although definitive conclusions could be drawn, a study lasting one year or more, and involving multiple teachers and multiple classes, is in order.

Further studies are needed to examine the relationship between a classroom's location in the building to student performance, and whether natural light from windows is beneficiary. Also, the geographic direction of the classroom (north, south, east or west) should be studied for its effect on student performance.

In addition, I would recommend more research on the effects of classroom temperature to student performance. The classrooms where I conducted my studies are on the second floor, and I observed these rooms to be warmer than lower level classrooms. Research is needed to determine if this is a benefit or hindrance to students.

Conclusion

In conclusion, it has been demonstrated through research and experimentation that moving students to the front and center of a classroom gives them the potential for higher performance on assessments that test newly learned material. This information can help teachers design classroom seating plans that maximize student potential and minimize student distraction. It can also help teachers who are having difficulty with student behavior or performance. This gives teachers yet another tool to help students receive a more thorough, effective and meaningful education.

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Appendix 1—Sample Questionnaire I

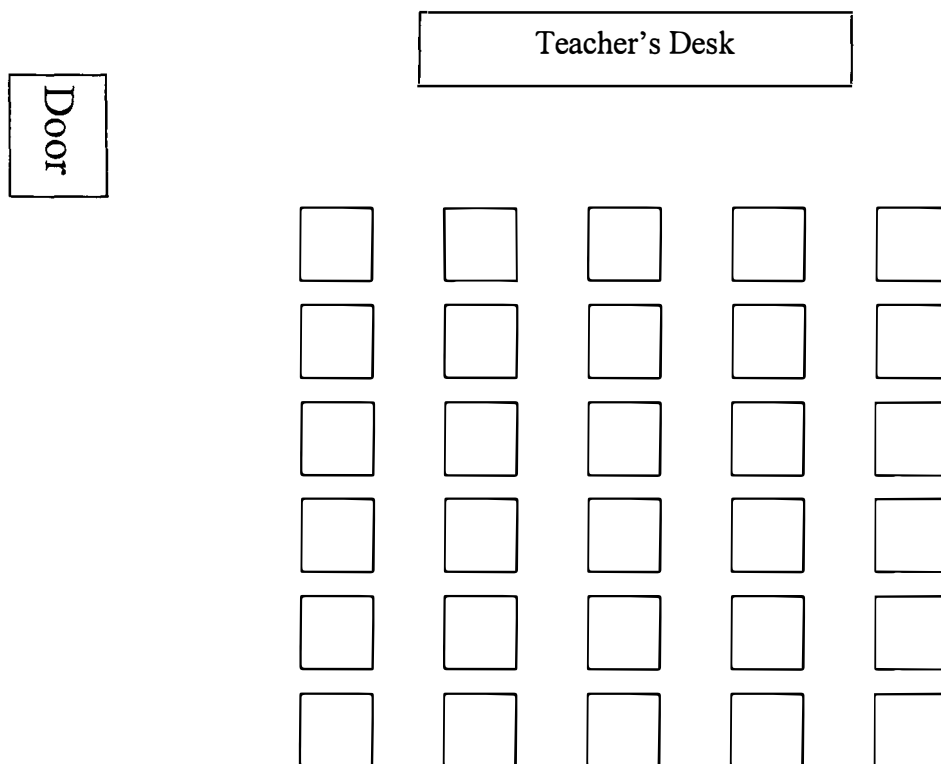
Remember: DO NOT put your name on this sheet!

1. Define Reduction--

2. Which electrode gets LARGER as a Redox reaction proceeds--

3. Where can you find an example of Electrochemistry (Redox) in your daily life?

Please mark your seat on the following map with an X:



Appendix 2—Sample Questionnaire II

Remember: DO NOT put your name on this sheet!

1. What does “saturated” mean?

A technique I use “In other words”—
it phrases things differently to help
clarify or explain what I am asking

2. What is unique about an alkene? (IOW—How can you identify an
alkene?) _____

3. Draw 2,2 -dimethyl hexene:

Please mark your seat on the following map with an X:

Door

Teacher’s Desk

<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>