IMPACT OF GENDER IN STUDENT'S INTEREST

AND SELF EFFICACY IN

MIDDLE SCHOOL SCIENCE

by

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ABSTRACT

This study focuses on what the possible impact of gender in the middle school science classroom could be. This focus was decided on by an interaction observed in a science classroom where male students gravitated towards a male English Language Learner aid for question rather than the female teacher. There were two treatments and two instruments used to investigate. The two treatments consisted of an intentional seating arrangement and a model summative. The seating arrangement was so ensure that each student was seated with the same gender on one side and opposite gender on the other. The purpose was to observe which gender students naturally gravitated towards during group work and how their participation and/or collaboration may have altered. Students were then assigned same group partners to complete a summative which asked them to build a 3D model and a 2D model. The two instruments used were Pre and Post Likert Surveys and focus group questions. These were used to gather data on students' opinion and feelings about science and about working with the same gender/groups. Results showed an increase in participation and more involvement in group work. It also showed that the impact of gender may not be as prominent as thought, but more so students understanding how they think so to find a partner that compliments their strengths and weaknesses.

INTRODUCTION AND BACKGROUND

I am in my twelfth year of teaching science and eighth year of being in middle school. It was when I stepped foot into an eighth-grade classroom at Franklin STEAM Academy (FSA) in Champaign, Illinois that I began to understand how learning varies not only through Multiple Intelligences, but also gender. I began paying closer attention to how students interacted with each other and the adults in the room. This is when it was observed that, often, when females were paired with males in a group, they were less likely to challenge the males in their thought process and/or give their perspective or idea. If there were multiple females in a group with males the females would discuss and confer amongst themselves rather than including the male members of the group. The question then became how can same gender grouping, impact learners in the science classroom? It was also noticed that some students were disengaged from the class before experiencing it. What can cause these preconceived notions of science, and how can these barriers be broken down in classrooms to allow students to gain more interest and further their thinking?

Research done by Staus et al. (p. 47) suggests that interest in science and STEM related topics and disciplines declines over the years that youth are in school. She and her colleagues mentioned that this pattern tends to be most pronounced for girls, non-white ethnic minorities, and urban low-income youth who report fewer positive attitudes about science. She states "Although, there is much research about university age students and their influence in science, the middle schools' years are still inconclusive, but more of a focus now as we see the younger years being more influenced" (p.47). Staus' research is one of the driving forces behind the action research question of the capstone, because of the lack of data collection during the middle school years. The declining patterns that she and her colleagues found give a starting point for understanding any relationship that impacts student's self-efficacy and/or interest in science.

This research is pertinent to the development of educational practices for educators in all areas of the field. The research is applicable to FSA due to it being a STEAM academy, and the significant emphasis on inquiry-based learning, and development of critical thinking amongst students. Teachers are encouraged to build curriculum that supports student interest and can reach all learning modalities and interpretations. The data gathered during the research provides an opportunity for better grouping of students, more intentional activities where students can access success and confidence, and better support for students to build up their self-efficacy in the subject.

The primary research question is "How does gender impact student's interest and self-efficacy in middle school science?" The sub-questions that are asked are as follows:

1. How do outside and in class influences impact students confidence/view of science?
2. How does gender and grouping of students influence their confidence and success in class?
3. How does understanding the impact of gender in the classroom impact me as a teacher?

Throughout the research the principal and science colleagues of FSA assisted in collecting and analyzing the data. Their contribution brought a balanced perspective to the data analysis, and perception of student behavior observed in the classroom. Jeffrey Lewis (husband) is a key part in this study due to his involvement with the community as an optometrist, and his heightened ability to see patterns and trends in data sets. The outside perspective can bring a more wholistic view to what is occurring in the classroom as his interactions bring different outcomes.

CONCEPTUAL FRAMEWORK

While observing student group interactions there was an interesting experience noticed regarding the male aid that was placed in class to assist English Language Learners. The aid had no prior education or experience in the sciences. It was observed that students gravitated toward him with questions pertaining to science concepts being learned that day or the instructions given for the activity. Did students need a different method of explanation? Was the task at hand the point of confusion? This observation sparked interest in gaining more understanding as to what may have led them to the aid for answers.

Due to the nature of the research much of the data collected was rooted in observation of student behavior, and outcomes in work done in class which equated to more qualitative than quantitative data. Kozleski (2017) states “Qualitative methodologies can shape and advance important questions of educational practice and policy” (p. 19). She continued noting that qualitative research stems from experience and/or observation to produce knowledge about perspective, setting, and technique. This further supports the direction of this action research and why a qualitative path of investigation is essential in understanding and developing ways to improve the learning environment for student success.

While researching various kinds of publications many researchers used a variety of quantitative and qualitative methods of data collection to obtain the strongest outcomes possible. It was seen that pre and post tests were common strategies used to determine changes throughout the study. These were both given during the implementation phase in the form of a Likert Survey and found valuable for analysis of thoughts and opinions from students. Many of the questions had extension opportunities where students could explain the reason for their choice on the scale. This was helpful in gaining a better understanding of the possible connections between declining interest in the sciences and any possible preconceived notions or ideas to be had before entering the classroom.

Research done by Haladyna and Thomas (2015) found that child insecurities and general disklike for school may start as early as the fourth grade. They surveyed nearly three thousand students ranging from grades one through eight across various subjects within the Oregon Public Schools and their findings were alarming. Between the eight scales used to collect data between subjects, they found the most significant decline between sixth and eighth grade alongside a large-scale decline amongst grades four through eight in attitudes toward virtually everything that happens in school. They concluded “There is an unmistakable decline in attitudes toward school which begins early in the education careers of the students surveyed” (p. 25). After preliminary work was done, they found that “The teacher may play an important role in shaping or influencing the attitudes of the classroom as an aggregate” (p. 27). Meaning, teachers may have majority influence on student perception of the subject and/or school in general. This puts the emphasis on the importance of intentional curriculum development and understanding in how students think and interpret so to assist in building confidence and self–efficacy.

There are many factors that play into the reasons behind the declining interest in school. Some factors can be addressed in school, while others need to be addressed by the community or home. A group of researchers found two very influential factors that teachers and school systems can influence for a positive outcome-mindset and anxiety. Huang, Shang, and Hundson, did a study in 2002 that focused on underrepresented females in the mathematical and science fields. They were investigating what was causing the drop in interest in math and science career fields. They found that growth mindset or the lack thereof, may be one of the leading culprits in a lower number of females in the math and/or science fields. They argue in their study

> A person with a fixed mindset, who does not believe that effort can lead to increased ability, is more likely to stay at a low level of self-efficacy if he/she starts with low self-efficacy on a task. Conversely, a person with a growth mindset is more likely to develop a higher level of self-efficacy because he/she believes that effort leads to increased ability (Huang et.al., 2018)

This research led them to dive deeper into the possible impact of implicit theories of intelligence (a belief system formed those triggers motivations and leads to different learning pathways (Liu, 2021)) on students at middle school age.

Huang and colleagues focused on three specific points of investigation.

> (1) whether middle school girls and boys differ in their perceptions on mathematics self-efficacy, mathematics anxiety, implicit theories of intelligence, and career interest; (2) whether the relationship among the aforementioned variable differ by gender; and (3) whether mathematics self-efficacy mediates the effect between mathematics anxiety and career interest and that between implicit theories of intelligence and career interest. (p.)

Their research surveyed 152 seventh grade math students from a rural school in the middle of the United States. There was an approximate even split between male and female. They used multiple Likert scales, one being the Anxiety Scale for Children (MASC) to determine where students fell in relation to anxiety and implicit theories. Teachers implemented these measuring tools near the end of their spring semester and gathered quantitative data to give to the researching team.

Their findings revealed a moderate difference in gender in terms of the impact of anxiety and growth mindset. “Mathematics anxiety has a direct effect on mathematics and science career interest for girls, while growth mindset has an indirect effect on mathematics and science career interest for boys." They quoted Wigfield and Eccles (2002, p.112) stating "Experiences in early adolescence can significantly impact a number of motivational outcomes as students go through various biological, cognitive, social, and educational changes." This leads to the possibility that students entering a class, such as science or math, with a preconceived viewpoint may have a fixed mindset about the subject already due to previous or past experiences. Huang and colleagues found that this fixed mindset can raise anxiety levels and prevent students from asking questions, participating, and encouraging themselves. In turn, hindering their self-efficacy and the possilbility of furthering their interest or study for that subject (science).

Although the results of the study were inconclusive regarding implicit theories of intelligence and gender differences, Huang and colleagues still believed that, as early as elementary school, students having anxiety towards math and science can impede the ability to have a growth mindset and lead to a lesser interest in the science and math fields as they continue their education and even into the work force. They also implied that the possibility of differentiated instructional strategies for different genders may foster more interest in the mathematics and science fields in middle school.

With the understanding that students entering a classroom, such as science, may have a fixed mindset, anxiety, and/or low self- efficacy, curriculum becomes the focal point. The question of how to create an engaging curriculum that can build interest and confidence in all students no matter the deficit, gender, or mindset is a challenge that many educators tackle every year. Naizer, Hawthorne, and Henley from Texas A&M conducted a study in 2014, that focused on implementing a hands-on summer STEM camp about computer game programming that educated not only students, but teachers as well. Their findings were remarkable.

The goals of their summer project included "generating positive attitudes toward stem fields, increasing awareness and interest in stem careers, influencing students to seek college attendance, and having them consider a STEM field" (Naizer et.al, 2014, p. 30). The focus was on middle school students that met criteria of being in a low socioeconomic status and having non-college graduate parents or family members that they lived with. They wanted to assist these students in gaining interest in the sciences and become successful in a STEM field despite their circumstances. The criteria they used was part of a sub-question related to the primary AR question of this Capstone.

They wanted to show the students how STEM can impact their own world and what it can offer them to become better citizens. The camp was run by knowledgeable university students and professors that had a passion and deep understanding for the material. They even trained the teachers chosen to participate in the material presented at the camp.

Their research ran for 2 years using a focus group of 32 students with varied numbers ranging from sixth, seventh, and eighth grade. Students were chosen to participate in a summer program that got them involved in STEM activities and then carried these activities and learning objectives on through the upcoming school year.

Researchers used questionnaires for both pre and post study to gain an understanding of interest, aptitude, and enjoyment of the sciences. The data from the questionnaires led to the topics of interest being chosen, computer game programming and robotics. Researchers created engaging and hands on activities for students that were connected to the topics and relative to everyday lives. The camp was staffed with teachers and assistants that were both knowledgeable and experienced with the material as well as enthusiastic. They wanted to be sure that students found a direct connection between what the sciences can offer them in their world which made the level of engagement the focus. The belief was that if engagement was there the motivation to learn and question would follow. Researchers noted throughout implementation that "While attitude and motivation rather than content knowledge were the major focus, students gained significant knowledge regarding applications of math and science as well as using those concepts within a technology framework." (p. 30)

Teachers at the school the students attended during the school year were also involved in the study so to keep consistency in the students learning throughout their next year. Naizer and team provided teachers with the training and materials needed to understand how to educate within a context, and ways to bring it back into the classroom.

The findings showed that consistency and context was the key to the learning process for the young minds. The results were that student interest increased throughout the summer and into the school year ahead of them. Before the summer camp began it was recorded, using a Mann-Whitney U test, that

> Males endorsed higher ranks than females on 16 items relating to science, mathematics, technology, and problem solving. However, post-test results revealed that the program had a considerable impact on females' ideas about their abilities in these areas as there was an increase in ranking (p.31).

They found that with focusing on building attitude and consistency in learning helped reduce the gender gap regarding interest in math and sciences.

Understanding the impact of purposeful and relevant curriculum was an important component in the research because it allowed for students to experience consistency and begin to explore the subject of science with less or, in some cases, no anxiety. It also shows that curriculum can be catered to gender specific learning abilities so to reach as many students as possible.

Much of the research reviewed in studies made it clear that male and female students learn differently, and in turn, need to have their learning skills met in school to be successful. The Association for Curriculum Development (ASCD) is an academic publishing company made of professors and contributors in the world of education, and they published an article in 2004 about the disconnect between male and female students, specifically in middle school. In this article, With Boys and Girls in Mind, they quoted a teacher from an interview performed. The teacher states:

> For years I sensed that the girls and boys in my classrooms learn in gender-specific ways, but I didn't know enough to help each student reach full potential. I was trained in the idea that each student is an individual. But when I saw the positron emission tomography (PET) scans of boys' and girls' brains, I saw how differently those brains are set up to learn. This gave me the missing component. I trained in male/female brain differences and was able to teach each individual child.

Clements et.al, (2006) did a study regarding language and visuospatial abilities between men and women during specific tasks that were given, which supported the claim that not only individuals, but different genders use different areas of the brain more heavily than others for certain tasks. As subjects were completing the tasks given there was data collected on areas of the brain that were engaged (activated on a scan) during that time. Even though their study had some limitations such as smaller sample size (15 men 15 women) and quite an age range (19-35) their findings were quite significant. The tasks that were given to the participants showed a clear association with left hemisphere dominant for language and right hemisphere dominant for visuospatial. Clements goes on to state that “The major advantages of the study were the use of tasks that have consistently shown sex differences in previous studies and equivalent behavior performances between groups.” (p.157)

Ingalhalikar et al. (2013) supports Clement’s findings after performing brain imaging on 428 males and 528 females during performance of various visuospatial tasks and finding that “Male brains during development are structured to facilitate within-lobe and within-hemisphere connectivity…whereas female brains have greater interhemispheric connectivity and greater cross-hemispheric participation.”

Understanding how the brain responds to different activities led to a need for furthering research around the physiology of the brain, and the multiple intelligences of learning. Considering the impact of the physiology in learning allows for more consistency in planning which can allow for more accurate observation of gender interactions since what is being asked of them in their activity caters to both male and female ways of thinking.

While researching many different aspects of gender in education Diane Connell (2005), author of, Left Brain/Right Brain Pathways to Reach Every Learner, brought up a fascinating point; “Physiological differences of the male and female brain have an impact on how they internalize and perceive information.” (p.12) With these findings one could say that educators may benefit from knowing their own learning style, and which side of the brain they primarily use when creating curriculum. When they understand where they, themselves, are coming from then they are better able to serve their students.

Knowing what part of the brain is primarily used to process is essential in understanding students. Many may think developmental differences only coming from environmental impact, but according to Gunselmann, B., and Connell, D. there are physiological reasons for why our brains processes things differently.

In Gunselmann's article "The New Gender Gap" (2006) she and her colleagues do a deep dive into the differences in brain development and usage between males and females. The article focuses on why male students are falling behind in school systems in America.

They quote William Pollack making a statement in 1998; "Boy code, and how the list of societal beliefs about how boys should act from an early age by hiding their feelings leads them to less likely speak up and try new things due to shame and failure." (p. 95) The point of view from society on the male gender is very insightful when thinking about impact in the classroom. Is there a different way to approach male students when trying to get them to participate? How can male students feel more comfortable and confident in the classroom or small groups to answer questions or share ideas? In researching and implementing instruments focused on gathering data and interactions between gender, one can take Gunselman's research into consideration when interpreting/analyzing the answers/data collected from students.

The authors go on to talk about the physiological differences of the brain and how brain hemispheres processes information differently. They stated that "the left brain is more sequential and analytical which leads to primary response being auditory and/or verbal (writing, speaking listening etc.). The right brain is more intuitive and holistic in processing which leads to more visual spatial and/or visual motor responses." (p. 98)

In brain development females left hemisphere develops before males, which leads them to early development of reading, writing, and listening. Gurian's research on how boys and girls learn differently states "In general, female brains develop more quickly than male brains. Brain development in infants is often most pronounced in the right hemisphere and gradually moves to the left. In females, the movement to the left starts earlier than in males (p. 26)." This means that a female's ability to absorb more sensory data and complex verbal skills is higher than males. Gurian goes on to talk about the corpus callosum, which connects the right and left hemispheres of the brain. He states, "In females it tends to be larger (meaning having more neural connections) than in males, giving girls more crosstalk between the hemispheres of the brain (p. 26)." Males tend to develop nontraditional approaches to learning through movement and visual spatial skills. To test this in the classroom students were grouped by gender and assigned two separate tasks, each focusing a specific side of the brain for usage in completion. Results showed how students responded in their thought process during implementation. This allowed for further understanding of observations during the period of the study.

In understanding how the male and female brain work one could conclude that the traditional learning environment does not necessarily benefit students. One could also say that student understanding their own way of thinking and that of their teacher and classmates could enhance their learning. This directly connects to classroom environment and intentional curriculum. Like Naizer and her colleagues found out through their summer camp, specific consistent hands-on curriculum relevant to the students ignited the learning for all participants. There is such a way to develop curriculum to model after Naizers' summer camp and that is using inquiry and design-based teaching practices simultaneously.

Inquiry based science classrooms are a way to promote the opportunities to use different modalities of thinking. The kind of learning that happens during inquiry allows student to question, wonder, and challenge. An MSSE capstone written by Kathryn R. Madden focuses on inquiry-based instruction in a rural school. In her capstone she states “In an inquiry-based learning classroom, learners model scientist. All scientific pursuits are led by a question or se3ries of questions designated at determining the whys or what ifs of a natural phenomenon (2011, p. 4).” She emphasizes that for students to develop these questions necessary for inquiry they must be provided the proper tools, and teachers that have been trained in inquiry-based learning make all necessary tools and materials available (Madden 2011, p. 12) The focus is to question students, challenge their thinking, exercise problem solving techniques, and give them a stake in the learning. Inquiry based teaching should empower students to want to understand the why to improve their current environment. Taking into consideration how different genders learn by way of their biological make up, this may not cater to the movement or visuospatial skills of learning, but when paired with design-based learning a classroom environment can spark all areas of the brain as did Nazairs’ summer camp study.

Mehalik, Doppelt, and Schuun investigated design based or systems-based learning in 2008 when they were comparing inquiry-based learning to design based learning with the desire to close the equity gap in an urban public school. They implemented their design-based study approach in 26 classrooms and the inquiry-based learning approach in 20 classes. Their results showed that the design-based learning approach was more helpful to the lower achieving students or students that were disengaged. They based the reason for the outcome on the way the design-based learning was centered around a system of learning. “The issue of providing a framework in which students can peruse their own ideas is one of the main differences between a systems design approach when compared to a scripted inquiry approach.” (p.75) They continue to state that “the systems design approach is organized according to modes of different types of thinking, which is then scaffolded.” (p.75) Mahelik and colleagues explain that the design or systems-based learning is directly linked students’ own needs and encourages them to develop their own ideas and “engage in larger range of modes of thinking when compared with scripted inquiry. In addition, students must take responsibility and are accountable for their learning through keeping a portfolio.” (p.76)

When considering how gender impacts/influences student engagement and self-efficacy in the science classroom, one can only wonder how shifting the learning environment to embrace the various learning modalities that each gender biologically encounters through intentional curriculum, developing awareness of strengths in learning and obtaining information, and an understanding how to communicate amongst each other based on strengths, could build a community of learners that can thrive and support each other. In turn, this environment may encourage more students to be open to the sciences in the future.

METHODOLOGY

Treatment

The focus of the treatment was to put students in an environment that was intentionally arranged for them so to challenge their comfortability and thought process, with the goal being to observe and collect data on how the different genders learn individually and together.

Students were arranged in new seats at the start of implementation. Students had choice seating prior which led to a natural comfortability in their environment. The intentional seat change initiated the research as it allowed for true observation and comparison of their interactions and quality of work in new and unfamiliar situations.

To the best ability possible, students were seated with the opposite gender on one side and the same gender on the other or within close vicinity. This allowed for there to be a natural gravitation for work partners to be observed as well as assigned work partners by gender.

Students were given two summative tasks to complete after one week of observation. These tasks were to create a 2D model (presentation to explain the 3D model) and a 3D model (actual model representing presentation) on a topic of choice that had a focus on one of the three areas: improving our planet, the future of our planet, current/future challenges our planet is facing. Students used the design cycle (Figure 1) for two weeks as they created their 2D and 3D models. This cycle embraces both the inquiry based and design-based methods of learning which allows for whole brain thinking along with left/right side opportunities. Students were assigned to same gender groups of two or three for this portion of the treatment.

Design Cycle- Franklin STEAM Academy

Instrumentation

The instruments used were catered to the qualitative focus of data collection. There was an emphasis on opportunities for students to express their reasoning for choices and feeling that were experienced. After researching other studies and reading Action Research by Craig Mertler (2015) Likert scales, journaling, and student interviews seemed to be the most appropriate methods of data collection.

Vogt stated in 1999 that "A Likert scale is commonly used to measure attitudes, knowledge, perceptions, values, and behavioral changes. A Likert-type scale involves a series of statements that respondents may choose from to rate their responses to evaluative questions" (RC & Vogt, 199). By way of definition, gauging students' perception of and attitude towards science using a Likert seemed fitting.

After reading Action Research by Craig Mertler (2015) I understood that Likert scales can be tricky as they have a said "neutral" point for students to employ as an answer. Mertler mentioned that this gives them an "out" to not have to think about the question. This was taken into consideration and the scale was adjusted. Likert scales also pose limitations to answers with only single options to choose from. Therefore, there were extended answers to given questions so that students could explain the reason for their choice. Please see Appendix A for more details on the Likert Scale. Mertler goes on to say that “Rating scales can be used very effectively to measure students’ attitudes, perceptions, or behaviors.” This kind of data directly related to the sub questions asking about impact of gender in the classroom.

To be able to triangulate the Likert data there were both journal entries and focus group questions for students to answer. Using both types of qualitative data collection allowed students the opportunity to be fully transparent in the journal as a focus group can intimidate some. The Likert scale will focus on student attitude in the classroom such as comfort and confidence, along with confidence in the science subject itself. The journal entries and focus group questions students to dive deeper in their reasons for their feelings and thoughts. In addition, the focus group questions allowed for students to talk about their thought process during the 2D and 3D model building. This discussion was key in allowing students to share their experience while building and creating and give them the platform to question the process and improve for next time.

Since there were multiple modalities used to collect data, and the nature of the study was predominantly observational, it was important to gather enough qualitative data that could grouped and presented in a quantitative format to make comparisons. The below states how the data collection methods connect to the research questions that are being explored.

A) Data will show students beliefs and ideals prior to treatment

B) Data will show students level of self-efficacy

C) Data will give qualitative data of student opinions and self-evaluations

D) Data Reflects the impact of the treatments

Table 1. Data Collection Matrix

Data Collection matrix:	1	2	3	4	5
	Student Surveys (Likert Scales)	Varied Activities (Based on Left brain right brain thinking)	CAT Tool (Minute paragraph)	Individual Student Interviews	Teacher weekly Journal
Research Questions					
How does gender play a role in self efficacy and interest in science for middle school students?	AB	C	BCD	BC	D
How do outside influences impact students confidence/view of science?	ABD		D		

How does understanding the physical learning differences of male and female students impact curriculum planning?		C	C		D
How does understanding the impact of gender in the classroom impact me as a teacher?	D	C	C	C	CD

Using the triangulation method above allows for qualitative data to be gathered and compared in an organized fashion. These question groupings directly relate to the Likert surveys given and journal questions that were asked throughout the implementation.

It was necessary to have collection methods that allow for student feedback and personal experience to validate their experience in the classroom when working with individuals and groups. The qualitative data gathered also allowed for a more thorough understanding of students interpretation of the activities and environment. This then gave way for ideas to improve in the future.

Demographics

For the treatment to be most effective there was a need to choose the most gender diverse classes for data collection. Out of a total of six eighth grade classes taught, there were 3 classes chosen. The reason behind a larger sample was to gather as much data as possible. Even though there were three classes chosen there was a disparity between male and female, but it was the lesser of the disparities. The distribution of students is as follows in Table 2, below.

Table 2. Classroom demographic data

Science Class	# Of Students N=69	Males	Females	Free & Reduced Lunch	ESL	Special Education
6	22	10	12	17	3	0
7	23	9	14	12	1	1
8	24	9	15	14	2	3

The students in the classes range from ages 13-15. There are two students that turn 16 this year in eighth grade. The motivation of these students varies quite a bit due to this year being the first year back to a regular scheduled school day.

The learning level of the students this year is lower than years past. Having two years of online learning has shown its toll on the ability to comprehend, ask questions, and persevere through challenges. There are N=69 students for this study and according to Northwest Evaluation Association (NWEA) which gives the Measure of Academic Progress (MAP) test each year, 27 students have reading scores >50%. As an entire 8th grade class our students sit below average according to NWEA with an average RIT score of 221. Science can already be discouraging due to the advanced vocabulary and scientific language. If a student is already below reading level, their confidence is challenged even before setting foot into the classroom. These factors, coupled with need for convenience and outside influences, lower students desire to push themselves and try their best. Many students tend to give up during the design cycle process because they are asked to think deeper and create from scratch.

Due to discouragement, motivating students to investigate the world around them for the summative assessment used in the treatment needed heavy amounts of engagement with use of phenomena and hands on activities. When students were given the opportunity to choose their groups it was observed that there was a natural gravitation towards their friends for safety and comfort. This may have also been a side effect of the pandemic.

As stated above, the students learning ability can be in question for multiple reasons. This is even more of a reason to use intentional curriculum to engage students and show them what they are capable of if they allow themselves to take the risk and put in the effort.

To grade students' ability FSA uses Standards Based Grading (SBG). SBG is a system of assessing students in relation to standards and how they meet the standard. Teachers can give effective feedback using the specific criteria assigned to each task. SBG can also be a more equitable way to grade because students' grades build from one quarter to the next allowing students to see their growth and what they should be reaching for (Heflebower et al., 2014). The levels of grading in SBG are Beginning, Approaching, Meeting, Exceeding. Below is a table outlining the grades for the three classes and arranged by gender for each grade.

Table 3. Students' grades organized by class and by gender

Criteria Level	6	7	8
Beginning	M- 3 F- 1	M- 2 F- 1	M- 0 F- 1
Approaching	M- 6 F- 0	M- 4 F- 2	M- 3 F- 1
Meeting	M- 1 F- 5	M- 4 F- 5	M- 1 F- 7
Exceeding	M- 1 F- 6	M- 0 F- 7	M- 1 F- 6

One could conclude from table 3 that the females in science class tend to have a better understanding of the material taught. This would also show that females perform better on summative assessments. After researching left brain and right brain differences it could be said that the summative assessments are more geared to a female's way of processing or a right brain way of processing.

Data Collection Methods – Likert Scale

To analyze data effectively the Likert Scale was given in a Google form format and the data was collected onto a Google Sheet, so trends and patterns are easy to align with student's answers. There is a number representation for each answer from strongly disagree (number 1) to strongly agree (number 4).

After the data is collated onto a Google Sheet it was then sorted into three categories based on the focus of the question being asked. Groupings of question numbers and categories are shown below. In doing this there is a clear and concise way of comparing the pre-test and pos-test Likert Scale data.

Table 4. Collated Data Groupings-Likert Scale

Question Numbers	Categories
1-4	General school attitude questions
5-11	Attitude towards science questions
12-16	Feelings towards groupwork in science.

Data Collection Methods –Focus group & Journal Entry

In this data method there is a combination of both the focus group and the journal entry. The reason for this is that while the students are answering questions verbally, they are more likely to hold back some thoughts due to the public feel of the environment. Focus group questions are provided on paper, so students can expand on their answer if the wish to do so privately.

The sub-question “How does gender play a role in self efficacy and interest in science for middle school students?” is investigated via this instrument. The focus groups happen at the same time students are assigned to a station. One of the stations is the focus group with me. During this each student receives a sheet with the questions to write down their answer and/or read the question again after being asked. The sheets are then collected along with recording the conversation for each group.

The next step is to evaluate the recorded data and look for trends and relationships between the students' answers. The questions being asked are shown in Table 5 below.

Table 5. Focus group/Journal entry Questions

Question #	Question	Question Probe
1	What challenges do you have in science?	Do you have challenges with focusing or with the material?
2	What Successes do you have in science?	Can you think of an activity that you felt successful or confident when doing/completing?
3	If you could choose to work in an all-female or all male group, would you? Why or why not?	What would make you choose that? Why would the opposite not work?
4	Is where you sit in science class a key part of your success? Why or why not?	What role do your friends play in your success in class?
5	What could be improved about the classroom environment for you to be more successful?	What do you feel would allow you to work better in science?

These questions line up with the groupings from the Likert scale so to easily compare the data. After the answers are collected and sorted, they will then be placed in categories shown in the Table 6 below.

To ensure validity in the research there were multiple instruments used to gather data and cross reference responses from students with the primary and secondary research question(s). Lovelace and Brinkman posted an article about best research practices for measure students attitudes in science, and they stated that "student interviews provide rich data that can reveal new insights and allow for flexibility and clarification of student ideas (p. 606)." Interviews/focus groups were a key piece to data collection and triangulation. They made sense of the Likert Survey and allowed for students to give deeper reasoning for choices related to gender and grouping in the science classroom. To create a pre and post-test Likert Survey there was a reference to the Views About Sciences Survey (VASS) and the Views on Science and Education (VOSE). These gave some guidance in the types of wording and questioning that can be used when asking about attitudes towards science. Professor with Montana State University MSSE program Walt Woolbough gave guidance on the Likert Survey to have extended answers as to allow for students to expand on the key questions linked to the research questions. These answers were then cross referenced with the focus groups and teacher observation.

Observations are key pieces to validating qualitative data. Craig Mertler writes about the importance of observations and how the collection of non-verbal actions in the classroom when students are working independently or in groups can help the teacher better understand student's responses. (Mertler, 2020 p. 130) He goes on to say that interviews or focus groups are a tactical instrument to use when gathering qualitative data with a time constraint. Also, "interactions among the focus group participants may be extremely informative because of the tendency for people to feed of each other's comments." (Mertler, 2020, p.136) To ensure every student had a voice, there was a set of guiding questions for students to look at and follow along with a talking piece (squishy ball). The student with the ball was the leader of the conversation at that time and the only one that was allowed to speak. All of these methods allowed for the research to be checked and validated along the

Table 6. Collated Data Groupings – Focus Groups

Numbers	Categories
1-2	Attitude towards science
3-4	Group work and seat placement
5	Improvements for success

DATA ANALYSIS

The data collected was primarily qualitative data. Many of the examples that are shown below are student comments and feedback from interviews given. The pre-test yielded 59 participants while the post-test yielded 52 participants. This may have been due to number of students present at the time, shifting in students from one class to the next, or students leaving the school entirely.

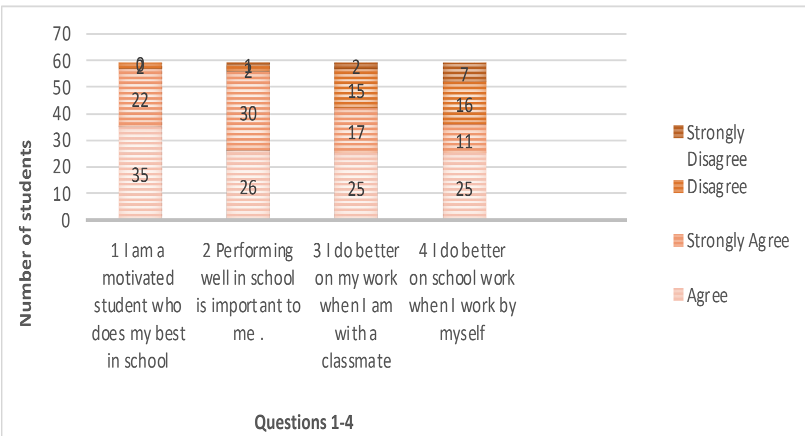

Figure 1. General School Attitude

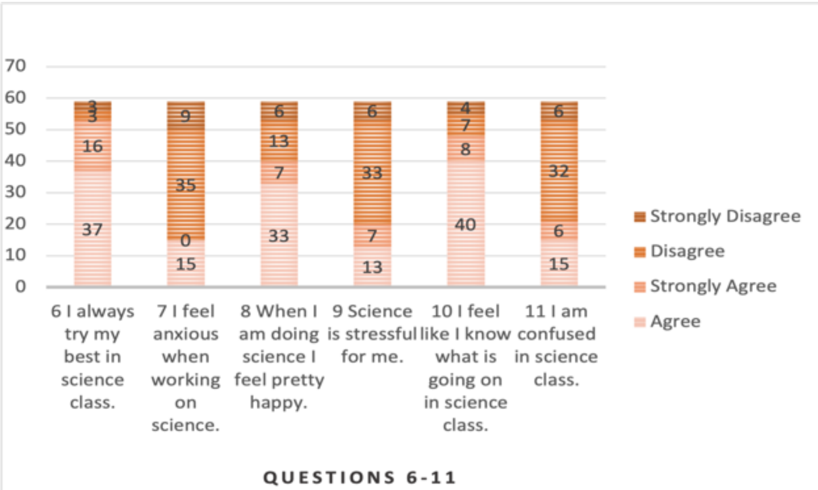

Figure 2 . Attitudes Toward Science

When looking at figure 1 and 2 one can say that the general attitude towards school and science correlate quite closely. Students seem to be motivated in school and want to do well with science being one of their subjects to succeed in. For the pr-test, 34 out of 59 students answered "agree" to question 1 in figure 1 claiming to be motivated to do their best in school. The same number of students (34) students responded "agree" to question 6 in figure 2 stating that they equally try their best in science class. In addition to trying their best it was interesting to see how students felt about different ways as to how to be successful in science class in terms of working with partners and which gender they would prefer. Figures 3 and 4 (below) show data that represents feelings toward group work and gender in science class.

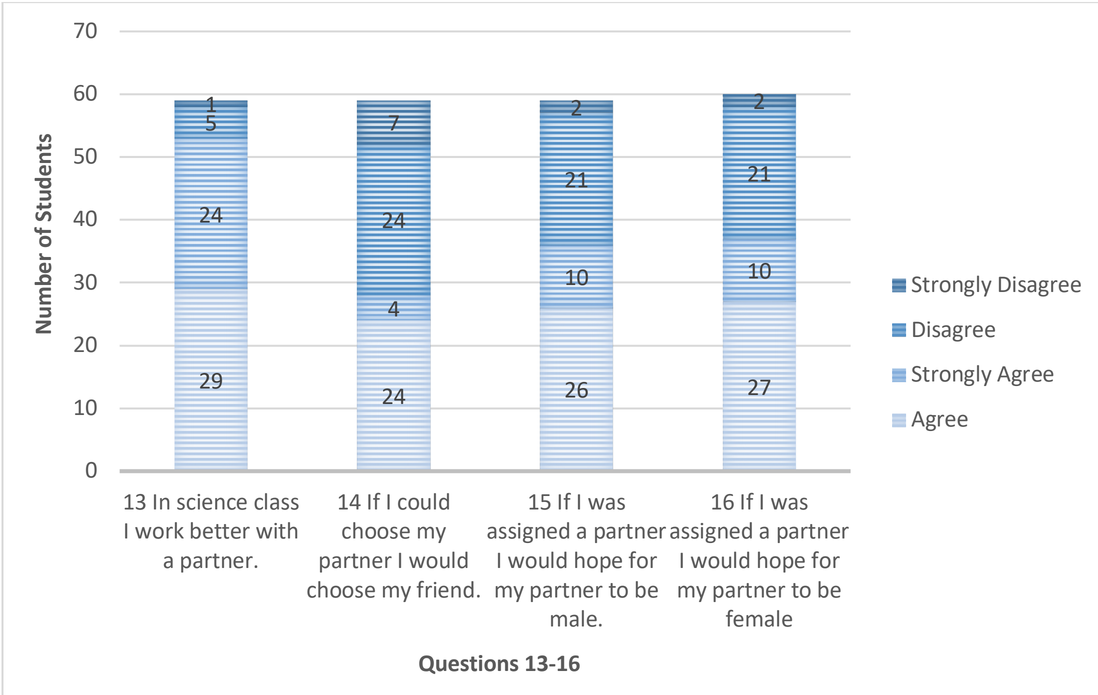

Figure 3. Pre-test Feelings Toward Group Work

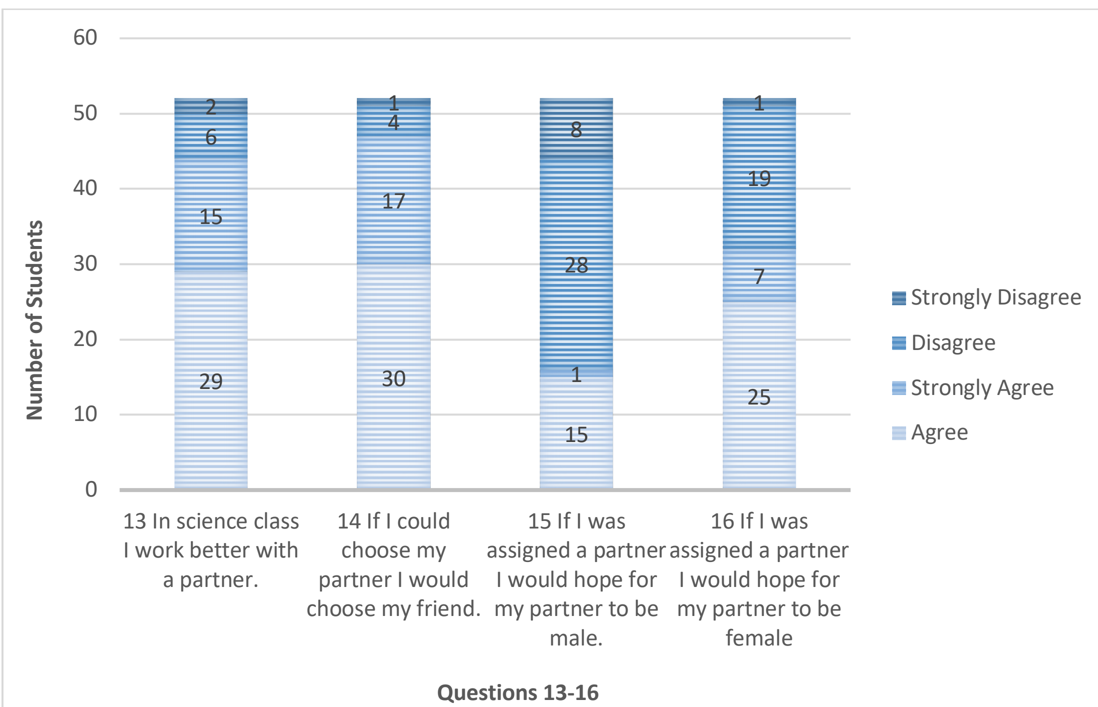

Figure 4. Post-test Feelings Toward Group Work

During the pre-test (start of implementation) many students stated that working with a partner was beneficial along with that partner being a friend. There was also an even spread of 26 students choosing to work with a male and 27 students choosing to work with a female. Many students chose a gender based on friendship. One student's reasoning for their choice was "I would rather be with males who are my friends and females that are friends too." Another student mentions "I wouldn't care but most of my friends are girls, so I chose girls." They didn't really have a desire one way or the other, especially females. Multiple females stated that the gender did not matter; "I don't care which gender it is, I only care if they're responsible enough to help me work along with them instead of sitting there and play games" one female stated. Another female response was "I don't really care too much with gender, only if it's someone I can work with, and they get things done." Males seemed to not have a direct preference about the gender, or they preferred their friends. An example of this was a student saying, "Because as a male I feel it would be easier to get along with a male partner than a female, but I think females can do the work too." There were many other responses from both male and female that stated gender was not a concern only if they could get their work done and focus.

As the treatment went on there seemed to be a shift in one of the gender students preferred to work with. When asked in the post-test (figure 4 question 15) if they would prefer their partner to be male, of those that chose "disagree" or "strongly disagree", 35 were females which was an increase from 18 females on the pre-test.

A reason for this may be due to the seating arrangements that were set at the start of treatment. Some females may have naturally gravitated toward their friend group which included males. When paired with a same gender group for the model building summative there may have been moments where it was recognized their thought process and way of communication was more cohesive and streamlined. There could have been a sense of safety to share ideas with each other. Evidence to support this is found in various student responses show below that have both a positive and negative interpretation.

a) "I know more female students and are friends with more females' students at school, and I work better and easier when I work with females, and I know how to stay focused and say what I want."
b) "I enjoy partnering with a female. I think I find it easier to communicate and do work with that partner."
c) "Males don't really focus or work a lot. They don't know how to listen."
d) "I don't agree with most boys in my classes."

Throughout the implementation there were student focus groups that occurred and there were two questions asked that showed results that could be linked to students preferring same gender grouping without knowing it. A total of 86 students were surveyed during the focus groups. Unfortunately, it was not the same students every time due to time constraints and absenteeism. This led to some difficulty in finding specific and consistent patterns.

One of the questions asked about the seating arrangement given at the start of the research where students were intentionally sat by the same gender on one side and opposite gender on the other. Many of the students were seated beside classmates they did not normally interact with.

This was an open-ended question, but many students answered yes, no, or maybe, so the table below has collated that data. Table 7 shows that many students agreed that their seat change was helping them be a more successful student in science class. Students were asked to expand on the answer if they felt comfortable. One student stated, “Right now yes, because even though it’s not next to my friends, they make class fun and actually make me interested in the lessons.” Another student expressed that the seat is “okay” even though it’s not near their friends, it is not distracting. There were other varied answers that mentioned there was “less distraction,” “better influence,” and “I feel comfortable asking for help.”

Student responses showed that when given the choice they would sit next to their friends, but they were able to see some benefits of switching up their seats and possibly sitting with other students of the same gender or thought process.

Table 7. Focus Group Question – Seating arrangement

Question: Is your new assigned seat in science class helping you be a more successful student?		
Yes	No	Maybe
69	8	9

The second focus group question more direct about gender asking, “Thinking about the groups that you chose for your DNA model and the same gender groups you were assigned during your Earth Model, which group do you feel helped you focus more and do your best?”

This too was an open-ended question, with students answering yes, no, or maybe and many had extended answers. Table 8 shows the outcome of student response along with their reasoning.

Table 8. Student outcome and reasoning to extended responses

Student Preference	Students extended Response
Don't Care 32 students	a. It doesn't matter to me, but I have been working with the same gender and it has been going well. b. If I worked with someone one of a different gender, I wouldn't care as long as they're efficient. c. I don't think gender impacts how well I work with someone, but I know my opinion of them does. d. I think we need to learn to work with other people that are not the same gender as us
Same Gender 49 students	a. Most of my groups have been same gender. The work and communication were efficient, and everybody did their part. b. I work better with same gender because I just overall feel more comfortable with them and sharing ideas with them. c. Yes, because boys are hard to understand and get distracted easily. d. I feel more comfortable around people of the same gender. e. I like working with the same gender because we understand each other more. f. I feel like boys would be thinking on the same wavelength, so I like to work with the same gender, boys. g. Yes, because it is easier to communicate and focus better.
Choice Group 5 students	a. I like working with my friends because they know me.

The research sub question being addressed askes "How does gender and grouping of students influence their confidence and success in class?" One could conclude, as before, that students may have more success with same gender grouping based on the biological functioning of the brain and how communication can be improved with same genders. It is also noticed that some students may not have a preference. When looking at students' grades and which students had preference of same gender grouping or not, some of the students that were achieving high meeting and exceeding grades on the SBG scale fell into the "I don't care" category. This may be because of already present high-level processing and thinking in the sciences, so their level of confidence is already established along with their heightened ability to communicate clearly and ask pertinent questions.

While looking through the data, the consensus after implementation of treatment and instruments was that student's overall attitude towards science increased in positivity (shown in figure 5 and figure 6). The Likert question asking them to rate their enjoyment of science yielded a 59.3% response for "agree" for the pre-test and a 71.2% response for "agree" for the post-test. There was also a drop in number of students that "strongly disagreed" to the question of liking science class, but a steady number of students who truly do not enjoy science class.

This may mean that students had a better enjoyment in science when they felt confident in understanding subject material. This could have been influenced by intentional grouping or changing of seats, which some students said helped them focus, or the summative assessments given were able to reach students interest and ability better when paired with their understanding of material.

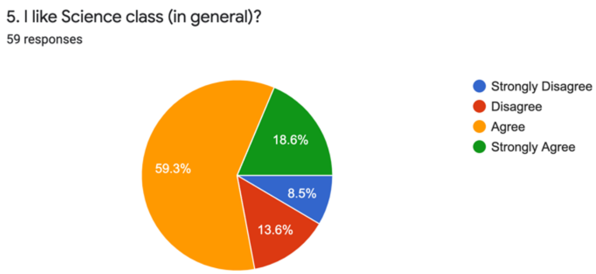

Figure 5. Pre-test data for question #5

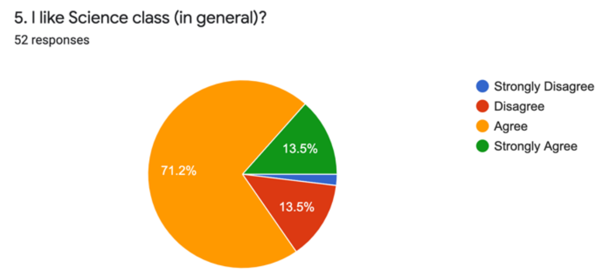

Figure 6. Post-test data for question #5

Students had an opportunity to explain the reason for their choice on this question. The replies for this question seemed to have shifted from general answers on the pre-test such as: "The teacher" "It's fun" "There's cool stuff" "Relationship with classmates" to more specific reasons that focus on the concepts learned and activities experienced. Some examples of post-test responses are: "Building models" "I like the thinking and problem solving. Plus, you get to physically make something instead of memorizing facts" "I can share my thought and do many projects, Ms. L also makes the lessons become really interesting" "Group projects" "Working with classmates I can cooperate with on big projects" "The group I was in."

These answers could be indicative of their seating arrangements or the model building project they were asked to do. Either of those reasons would be supportive responses for the treatment put into place which focuses on gender grouping and intentional curriculum. Both examples can be used to answer the initial research question of "How does gender impact students' interest and self-efficacy in middle school science?"

The collection of data shows that there should be further investigation to delineate the impact of the grouping and intentional curriculum as separate entities. When collecting these data sets students were unaware of the reasoning behind the questions, grouping, and seating, other than this was a research study. The reason for this was to keep them from forming pre-conceived notions or opinions. When furthering investigation of the two areas it may be helpful to bring students in and have them be more conscious of their understanding of concepts, group interactions, and all-around feelings towards their environment. This may also help build their self-efficacy in the class and school in general.

The purpose of this study was to answer the primary question, “How does gender impact student’s interest and self-efficacy in middle school science?” To aid in answering this primary question there were two treatments implemented which were: arranged seating by gender, and an intentional summative created around the physiological way male/female brains work.

The arranged seating was to answer the sub question “How does grouping students by gender influence their confidence and success in the class?” According to research about learning styles done by professors from Penn State University males tend to prefer a more traditional learning style which means males tend to lean more towards a logical and rational approach to learning. While on the other hand, females are the opposite, and excel at understanding people, identifying problems, brainstorming, and imagining (Kulturel-Konak et al., 2011 p. 12). This could support some of the results of the post-test given that many students had preference of what gender they worked with. Some of the reasons for this were physiological, who their friends were, and the ability to trust their partner(s) would do their fair share of the work. Students were able to express their thoughts further through focus groups and extended responses.

The question asked in the post-test “If assigned a partner I would hope for my partner to be a male” 35 were females replied with either “disagree” or “strongly disagree” which was an increase from 18 females on the pre-test. When triangulating that data with student responses during focus group/interview sessions many females mentioned they preferred same gender grouping because there was “less distraction,” “better influence,” and they felt more comfortable asking for help and sharing ideas. This aligns with the physiological studies about the brain and how females and males process differently. If students understood this, they may choose their groups based on how they think rather than who they are friends with. This could lead to more confidence and better self-efficacy in the science classroom. While the grouping of students is quite important, so is being intentional with the curriculum and the educator understanding their physiological processing as well.

The data also showed that when students are given the choice to choose their groups or seats their focus is on grouping with their friends and/or students with a similar work ethic as them. They are not inclined to go outside of their comfort zones of who they know, which, seen through the data, can lead to new inspiration, connections, and new perspectives on the subject of science.

Kulturel-Konak mentions in their study that "It is clear that the use of a variety of teaching techniques will provide the most success in appealing to the broadest range of student learning styles." (p. 11) Teachers that have a better understanding of how they teach (their physiological learning style) will be able to create more intentional and accessible curriculum for their students. I personally took a physiological left brain/right brain function test, and my results showed right brain dominant. If I was to assume that this was how I created my curriculum using more right brain skills and processing, and many students reaching exceeding in my class are female, one could say that my science class is not as accessible to males as it is females. There needs to be further research done to provide a more accurate connection and conclusion for this, but the research and data do align that there can be a connection of self-efficacy and gender or teacher and or classmates.

Teacher Implications

Based on the data collected through this study, I do believe that gender may have an impact on self-efficacy in middle school in terms of who students work best with in regard to learning styles and brain development. Gurian states that biologically, girls' left hemispheres develop before boys. Conell and Gunzelmans' research shows that boys and girls have different brain biology and development. Girls develop the ability to write and communicate earlier than boys, which leads to boys "catching up" to girls later in schooling (p. 98-99). Likewise, Naizers' research focuses on how, in middle school, self-efficacy tends to drop dramatically for students for a variety of reasons around developmental changes, teaching styles, and classroom/student interactions (p. 30). Knowing how to group students for success and plan curriculum to allow full access of understanding could raise interest, self-efficacy, and confidence in students. Science may not become their favorite subject, but they will have a better understanding of themselves as a learner, their needs, and possibly how to communicate better with the teacher and students. There should be purpose and intention behind each seating chart, each activity, each assessment created. The way the brain is working and developing at the middle school ages of 13-15 is remarkable, and the students need to trust that teachers understand this and give them tools to be successful in their class. They process many different things at one time, and it can be challenging for them to focus in class. This can cause them to lose confidence or think they aren't smart enough.

In response to my question on how this impacts me as a teacher I will be making many adjustments in the upcoming year. I will be giving students right brain/left brain surveys and we will be discussing what these mean and any protentional impact this knowledge can have on their learning. Students will understand that there is a factor for error in this test, but that it will give them a baseline of knowledge for how they interpret different scenarios. This will also help to create appropriate curricula for all students to be able to access successfully and build their self-efficacy in science class.

The same gender grouping can offer students another perspective and possibility on how to succeed in class, and I plan on implementing this more often, with a reflection piece at the end so students can think about why this grouping was successful or not. There can be discussion built around this and a more concrete understanding developed, so as they leave middle school and go into high school, they can make the best decision for them regarding grouping and learning. When asked about who they enjoyed working with or would choose to work with, many students seemed to always gravitate towards their friends. There would need to be a clear definition of what they consider a friend at that time. Whether it be a friendship they have had for many years, or a student they were just grouped with and then considered them a friend. This clarification would allow for more accuracy in understanding if the same gender grouping brought new friends to light that they felt comfortable with and communicated well with, or if their friends are same gender or not.

Students did showed an interest in doing better in class when in their same gender grouping. More questions were asked, more participation was shown, and groups were communicating more in depth, without distraction, about their task at hand. They may have built friendships along the way and noticed that being mindful of who they choose to work with during certain tasks can be beneficial to their thought process and their success and confidence in class. Students usually do not choose different partners on their own, which means that the teacher would need to facilitate the grouping and encourage students to work outside of their comfort zone. This may give students an opportunity to see that they may work better with same gender classmates that think & communicate like them.

Our middle school students are brought into a world where the focus of gender is about sexuality, but there is more to it. Understanding physiological differences of brain development takes the pressure from making decisions based on “social” platforms. It allows for choosing groups to be about intellectual community rather than social community.

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APPENDIX A: PRE/POST LIKERT SURVEY

<u>Instrument #1 - Student Likert Survey</u>

1. I am a motivated student who does my best in school.

   Strongly Disagree Disagree Agree Strongly Agree

2. Performing well in school is important to me.

   Strongly Disagree Disagree Agree Strongly Agree

   Extension: Why did you choose the above answer for this question?

3. I do better on my work when I work with a classmate.

   Strongly Disagree Disagree Agree Strongly Agree

   Extension: What is the reason for your choice in question #3

4. I do better on schoolwork when I work by myself (independently)

   Strongly Disagree Disagree Agree Strongly Agree

5. I like science class.

   Strongly Disagree Disagree Agree Strongly Agree

   Extension: What is it about science that you like the best?

6. I always try my best in science class.

   Strongly Disagree Disagree Agree Strongly Agree

7. I feel anxious when working on science.

   Strongly Disagree Disagree Agree Strongly Agree

   Extension: What causes may cause you to feel anxious?

8. When I am doing science, I feel happy.

   Strongly Disagree Disagree Agree Strongly Agree

9. Science is stressful for me.

Strongly Disagree Disagree Agree Strongly Agree

Extension: What about science can be stressful for you?

10. I feel like I know what is going on in science class.

Strongly Disagree Disagree Agree Strongly Agree

11. I am confused in science class.

Strongly Disagree Disagree Agree Strongly Agree

12. In science class I work better alone.

Strongly Disagree Disagree Agree Strongly Agree

13. In science class I work better with a partner.

Strongly Disagree Disagree Agree Strongly Agree

Extension: Why does having a partner help you work better?

14. If I could choose my partner, I would choose my friend.

Strongly Disagree Disagree Agree Strongly Agree

15. If I was assigned a partner, I would hope for my partner to be male.

Strongly Disagree Disagree Agree Strongly Agree

Extension: Explain why you chose your answer

16. If I was assigned a partner, I would hope for my partner to be female

Strongly Disagree Disagree Agree Strongly Agree

Extension: Explain why you chose your answer

APPENDIX B: INTERVIEW QUESTIONS

Instrument # 2 – Focus group/Interview Questions

1. What successes have you had in science? (Ex: an activity you felt successful or confident in doing)

2. What challenges do you have in science? (Ex: focusing or concepts) give a possible solution to/for your challenge.

3. Is where you sit in science class helping you be a successful student? (Think about success not so much sitting with friends)

4. based on the groups you have chosen and been assigned to this year do you feel like you work better with same gender? Why or why not?

5. What could be improved in the classroom environment for you to be more successful? (Allow you to work better in science)

APPENDIX C: TREATMENT

2D/3D Model Summative

OVERVIEW:

When thinking about our planet, living on it, how it works, what it needs, how it has changed, how will it change, how is it changing NOW? What is something that you would like to know more about?

Over the next couple of weeks, we will be embarking on a project to explore different geological or environmental issues. We will be researching topics about our earth's processes, geological threats, and environmental threats. You don't like the options given? Come up with your own (pertaining to earth) and ask me about it! Ideas are on page 2.

We are going to:

1. research that topic in detail
2. come up with a question that needs answered about our topic
3. Create a 2D model (presentation – slides, poster) will explain 5W's of 3D model
4. Create a 3D model that supports your 2D presentation

Criteria:

Each criteria will need to be signed off by me before you can move on to the next one.

Criteria	DESCRIPTION	Jobs Assigned	Signed
1	BACKGROUND RESEARCH – WHAT IS GOING ON? Use Graphic organizer		
2	VOTE ON YOUR GROUP'S TOPIC		
3	CREATE A QUESTION YOU WILL ANSWER THROUGH YOUR MODEL/PRESENTATION		
4	BACKGROUND INFORMATION RESEARCH Use Journal Doc in google drive (EVERYONE PARTICIPATES-DIVIDE WORK)		
5	FORMULATE PLANS: Weekly Plans: FOR COMPLETION OF MODEL AND SLIDES • Assign job(s) to each person in group. • Fill in the calendar with tasks for each day? • Break it into parts - research first/model build/presentation board.		

TOPIC IDEAS - CREATE YOUR OWN!	MODEL IDEAS
Fossil Fuels	Paper Mache

<table>
<tr><td>Model of the earth’s layers

• Plates, oceans, ring of fire</td><td rowspan="10">Pop Up Book

Mobile (hangs from ceiling)

Flip book

Topographical Map

Clay Models

Recycled Material Model

Kids Book

Whatever you would like!
<hr>MATERIALS PROVIDED<hr>Shoe boxes

News Paper</td></tr>
<tr><td>Greenhouse Gases</td></tr>
<tr><td>Waste

(trash, oil, fishing, factory ect.)</td></tr>
<tr><td>Water Crisis</td></tr>
<tr><td>Ocean Temperatures Increasing</td></tr>
<tr><td>Deforestation</td></tr>
<tr><td>Sustainable Energy</td></tr>
<tr><td>Magnetic Field of the Earth</td></tr>
<tr><td>Historic Event of Earth - Mass extinction</td></tr>
<tr><td>Predictions On Future earth based on Patterns.</td></tr>
</table>

	Recycled bottles/ cans Yarn/String Cardboard Markers/Colored Pencils Straws Popsicle Sticks Hot glue String/Yarn Construction paper Tooth picks Pipe Cleaners Beads (blue, black, white)