St. Catherine University

SOPHIA

Masters of Arts in Education Action Research Papers

Education

7-2021

The Impacts of Peer to Peer Collaboration on Science Self-Efficacy Among 8th-Grade Students

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Submitted on July 26, 2021

in fulfillment of final requirements for the MAED degree

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Advisor : Dr. Megan Olivia Hall Date: 7/26/2021

Abstract

This action research project focused on determining the effects peer-to-peer collaboration has on 8th-grade students in a middle school science classroom. The intervention took place over six weeks in two classrooms, whose learning models changed between hybrid and distance learning due to the COVID-19 pandemic of 2020-2021. For this study, researchers collected data through a pre and post-intervention science self-efficacy questionnaire and digital journal, and twice-weekly exit tickets. The results showed that the peer-to-peer model of collaboration implemented in this study increases student self-efficacy significantly, with girls having the most significant increase in self-efficacy. Researchers concluded that this model is an effective tool for supporting self-efficacy growth in the 8th-grade science classroom. Based on the results of this study, the researchers recommend implementing regular peer collaboration, teaching collaboration skills to support effective communication, and increasing the practice of self-reflection for students and teachers. Further research is needed to address how adding hands-on activities would affect self-efficacy and why female BIPOC students did not show the same levels of growth as their peers.

Keywords: self-efficacy, vicarious experiences, peer to peer collaboration, communication, metacognition, science, middle school

Adolescent students experience many changes as they go through the middle school years. In addition to the physical and emotional changes children go through as they reach puberty, the educational transitions students experience during adolescence can also affect students' beliefs about their abilities (Lofgran, Smith, & Whiting, 2015). The changes in students' beliefs about their abilities often include negative attitudes and a decrease in their self-efficacy beliefs. Self-efficacy beliefs are strongly correlated to academic achievement, and gains in self-efficacy also increase academic achievement (Pajares, 1996; Kapucu, S., 2017).

By definition, Self-efficacy is an individual's beliefs surrounding their ability to complete tasks successfully (Bandura, 1977 as cited in Brown, 2016, p 27). Self-efficacy is developed through many sources, but two of the most crucial sources are mastery experiences, which is when an individual takes on a challenge and succeeds, and vicarious learning, which is learning that is developed by observing the behaviors of others and the outcomes of those behaviors (Brown, 2016, p 27). Therefore, by providing opportunities for mastery experiences and vicarious learning, a teacher can support growth in self-efficacy and academic achievement.

Increased opportunities to develop self-efficacy are beneficial to all learners. However, changes in attitude and self-efficacy as students transition between school settings are exceptionally prominent for girls (Falco, 2019). In the science classroom, self-efficacy also tends to be lowest for female and Hispanic students (Lofgran et al., 2015). For both female and Hispanic students, lower self-efficacy in the science classroom is related to apprehension and anxiety (Pajares & Johnson, 1996 as cited in Lofgran et al., 2015). It is also important to note that "by the time students reach middle school (grades six through eight), the majority have already determined significant preferences toward certain academic domains" (Wigfield &

Eccles, 2002 as cited in Falco, 2019, p. 28). These preferences are a concern because, over the past 30 years, there has been a decline in the number of students entering into science and technology-based careers (Brown et al., 2016). Even for women who hold degrees in Science, Technology, Engineering, and Mathematics (STEM) fields, employment is less likely than for men with similar degrees due to a lack of confidence and career self-efficacy in STEM (Falco, 2019).

The middle school science teacher faces the challenge of increasing students' self-efficacy to improve their academic achievement and prepare them for future academic studies and careers. Research shows that for sixth through ninth-grade science students, girls have significantly lower self-efficacy beliefs than boys, and Hispanic students have substantially lower self-efficacy beliefs than white students (Lofgran et al., 2015). Furthermore, self-efficacy tends to decrease, on average, for all learners as they progress through the middle school grades (Lofgran et al., 2015). In the settings in which the authors teach, historically, Science MCA's have had lower proficiency levels than those of Mathematics and Reading in the eighth grade. For example, in one research setting, from 2016-2019, students have averaged a proficiency level of 49.3% for science while mathematics averaged 73.4% and reading averaged 63.6%. Similar patterns appear when analyzing student engagement within the building. According to the Minnesota Report Card for this research setting (2019), 98% of students responded that they tried to learn more about content when they are interested in it. Yet, only 81% of students found school useful to their learning, and 65% of students saw being students as important (Minnesota Board of Education, 2019). This data shows a sizable gap between students who find the content they learn in school interesting and relevant and students who feel disconnected from the entire learning process.

Problem Statement

Students who have firm beliefs in science self-efficacy are more engaged in the material and demonstrate increased achievement (Pajares, 1996; Kapucu, S., 2017; Hattie & Timperley, 2007; Schunk, 1995 as cited in Schrunk, 2012). Therefore if teachers can support students' science self-efficacy growth, students will become more confident in their understanding and abilities to work through the problems and issues in sciences both in the classroom and within our community. Along with an increase in self-efficacy, this will increase achievement in the science classroom because students will persevere through more abstract and complex concepts within the content area. Several strategies are available to increase self-efficacy, including self-paced learning, student self-perception, self-regulation, collaboration and peer modeling, and metacognition.

Based on this information and the unprecedented educational situation caused by the 2020-2021 COVID-19 pandemic, the intervention that we implemented was a peer-to-peer collaboration model. During this action research, the authors paired students to collaborate on the scientific concepts they were trying to master and reflect on their progression towards mastery. Groupings were fluid as students transitioned between learning from at-home and in-school settings while the 2020-2021 COVID-19 pandemic progressed. This action research project aimed to explore the following question: What impacts, if any, does a peer-to-peer model of instruction have on science self-efficacy in adolescents doing a hybrid learning experience?

Theoretical Framework

Bandura's Social Cognitive Theory focuses on how people can learn from their social environments (Schunk, 2012). Within this theory, Bandura (1977) identified that, in order to accomplish learning tasks, a person's self-efficacy must be at an adequate level, or they will be unable to achieve what is asked of them (as cited in Hsieh et al., 2008). "Self-efficacy is concerned not with the skills one has but the judgments of what one can do with whatever skills one possesses" (Lui et al., 2006, p. 228). Furthermore, increased self-efficacy is shown to increase academic performance at all ability levels (Schunk, 2012).

Within the context of self-efficacy, Bandura (1977) further describes four sources in which self-efficacy can be formed (as cited in Brown et al., 2016). These include mastery experiences, vicarious experiences, verbal or social persuasions, and physical and emotional states. Mastery experiences are those personal experiences in which a person takes on a new challenge and succeeds. Vicarious experiences involve students learning from other's experiences and successes. For example, when a student with low self-efficacy observes peer success, their own beliefs about their abilities can increase (Alt, 2015, p. 62; Schunk, 2012). Verbal or social persuasions are "when people are led, through suggestion, into believing they can cope successfully with what has overwhelmed them in the past" (Alt, 2015; Bandura, 1977, pg. 198). Lastly, physical/emotional states relate to the effects a person may experience.
Physical/emotional states could include increased heart rates or anxiety based on their current self-efficacy levels.

Out of these four states, research has demonstrated that mastery and vicarious experiences are the most successful at increasing student achievement through improving their self-efficacy (Bolshakova et al., 2011; Brown et al., 2016; Lodewyk & Winnie, 2005). Schunk (2012) and Alt (2015) find that collaboration and peer role models provide mastery and vicarious experiences for students. These researchers concluded that these models support increased student self-efficacy (Alt, 2015; Schunk, 2012). Vicarious experiences can also be provided to students when teachers model high self-efficacy through completing challenging tasks (Bolshakova et al., 2011). Increased exposure to a learning task can positively impact self-efficacy in students through mastery experiences (Lodewyk & Winnie, 2005). By working with peers in collaborative groups or through peer modeling and reflecting on that work with a repeated learning task, students can increase their self-efficacy (Alt, 2015; Lodewyk & Winnie, 2005; Schunk, 2012). The students' increase in self-efficacy can be further supported when their teachers are also practicing and modeling high self-efficacy (Bolshakova et al., 2011).

Review of Literature

The literature review below identifies several methods known to increase girls' self-efficacy and academic success in the middle school science classroom: self-paced learning, student self-perception, self-regulation, collaboration and peer models, and metacognition.

Self-Efficacy and Achievement Gains

When applying self-efficacy in the classroom setting, a student or a teacher's self-efficacy influences academic achievement (Bandura, 1993; Pajares, 1996, 1997; Schunk, 1990, 1991 as cited in Schunk, 1992). Students' self-efficacy can affect the quantity and quality of effort

(Bandura & Cervone, 1983, 1986; Schunk, 1995 as cited in Schunk 2012). For example, students with low self-efficacy may exhibit avoidance behaviors, have lower academic achievement, and are more likely to forget previously learned skills (Leaper, Farkas, & Brown, 2012; Lodewyk & Winnie, 2005; Schunk, 2012). On the other hand, students with firm self-efficacy beliefs tend to be eager to participate, put in more effort, persist through struggles, and have higher achievement than similar-ability peers (Lodewyk & Winnie, 2005; Schunk, 2012).

Furthermore, students' perceptions of progress can also link to their self-efficacy beliefs (Schunk, 2012). Higher self-efficacy beliefs increase the students' perception of their personal growth in understanding and completing the task at hand and can keep students motivated to learn by evaluating their progress (Hattie & Timperley, 2007; Schunk, 1995 as cited in Schunk, 2012). Self-efficacy tends to correlate with achievement; self-efficacious learners achieve better at all ability levels (Schunk, 2012). Improved self-efficacy could even affect achievement in post-secondary studies. Achievement can be affected because the factors that influence self-efficacy, such as self-concept, social support, and the value students put on their coursework, have more bearing on the gender and racial gaps in STEM fields than ability (Marra et al., 2009, p.28).

Self-Efficacy Strategies that Support Achievement Gains

Project-Based Learning

Project-Based Learning (PBL), which means "student-centered learning where students take responsibility for their learning processes and build knowledge through their learning experiences," has been studied in the middle school science classroom (Liu, Hsieh, Cho, &

Schallert, 2006, p. 226). Within PBL, students receive a problem and apply different high-order skills and strategies to find a solution. This strategy can lead to significant gains in self-efficacy, interest in STEM fields, and achievement because students control their learning (Brown et al., 2016; Liu et al., 2006). Liu et al. found that students who held high self-efficacy beliefs scored significantly better on the achievement test than those with low self-efficacy beliefs at multiple ability levels when involved in PBL activities (2006).

Self-paced learning--in which students control their learning and self-regulate their progress—has also been found to improve student self-efficacy (Brown et al., 2006; Chiu-Lin, Hwang, & Tu, 2018; Liu et al., 2006). Student control includes self-paced technology-aided learning, allowing students to self-regulate their education and work independently to master the content (Chiu-Lin, Hwang, & Tu, 2018). Additional benefits of self-paced technology-aided learning included improvements in: students' use of technology for "formal queries; information searching; time management; help-seeking; and self-evaluation" (Chiu-Lin, Hwang, & Tu, 2018, p. 885). Self-paced technology-aided learning also tends to make the students more reflective (Chiu-Lin, Hwang, & Tu, 2018).

Student Self-Perception

Students can shift Self-perception allowing through vicarious experiences and peer influences to improve students' self-efficacy. The perceptions and self-efficacy of people around students can help grow or diminish their personal beliefs of self-efficacy (Barton et al., 2013; Leaper et al., 2012; Bolshakiva et al., 2011; Morell & Parker, 2013). Many researchers have studied the effect of student self-perception on self-efficacy in STEM for female students and have found that positive peer influences increase self-efficacy for these students, whereas negative social cues about science decrease female self-efficacy (Barton et al., 2013; Leaper et al., 2012; Marra et al., 2009). By increasing opportunities for vicarious experiences in science and increasing education around feminism and gender equality, student self-perception and self-efficacy for girls in STEM increases (Barton et al., 2013; Leaper et al., 2012). Therefore, females' persistence in the sciences relies on girls maintaining a positive self-perception in science by seeing themselves and those like them in the scientific field. Students can obtain this persistence through placement in small groups where interest grows through the support of their peers (Leaper et al., 2012). Likewise, families and schools can also increase this self-perception by supporting female students in their scientific thinking and activities (Barton et al., 2013). Lastly, using role models representing females and different cultures can impact previous conceptions of women’s contributions to scientific fields (“Diverse Role Models,” n.d.).

Micromessages, including phrases, body language, and tone of voice, are delivered along with content and can also influence self-efficacy through self-perception (Rowe, 1990, as cited in Morell & Parker, 2013). When negative, these micromessages decrease self-efficacy. For example, "when a faculty member supervising laboratory experiments assigns the role of note-taker to female students, he or she may subtly imply that women are more capable as scribes than as scientists" (Morell & Parker, 2013, para. 6). However, when micromessages focus on being inclusive and listening, self-efficacy increases by creating a positive classroom environment for all.

Teacher self-efficacy can increase their students' self-efficacy by affecting students' self-perception (Bolshakiva et al., 2011). The more self-efficacy a teacher had in their knowledge of content and ability to teach, the more innovative their teaching strategies became. This strategy, in turn, increased student self-efficacy (Bolshakiva et al., 2011). These strategies resulted in greater student self-efficacy because the teacher modeled the ability to do challenging tasks (Bolshakiva et al., 2011).

Self-Regulation

Self-regulation allows self-efficacy to increase through tasks by enabling students to check their self-efficacy beliefs as they progress through the learning process (Falco, 2019; Lodewyk & Winne, 2005; Ramdass & Zimmerman, 2008). The research identifies several self-regulation strategies to increase self-efficacy. When students work toward completing well-structured tasks, they become more self-efficacious (Lodewyk & Winne, 2005). Students' ability to accurately judge their ability to complete tasks also improves as they reach the completion of a learning activity. The longer the student engages with the learning activity, the better they can self-regulate their learning and performance (Lodewyk & Winne, 2005). Strategies such as creating a time budget increase the time management aspect of self-regulation and lead to increased self-efficacy (Falco, 2019). In goal-setting, students break down broader objectives into smaller tasks and then apply them to be Specific, Measurable, Achievable, Relevant, and Time-bound (SMART), which significantly increase self-efficacy, especially in females (Falco, 2019).

Additionally, self-correction, a strategy where students check their answers for accuracy and precision while working on a performance task, is an aspect of self-reflection that also increases students' self-efficacy. In self-correction, students can differentiate between successful and unsuccessful strategies and find sources of error in their thinking (Ramdass & Zimmerman, 2008). In many of these strategies, students learn how to accurately judge their learning by using concrete skills, which leads to increased confidence in their judgment and increased self-efficacy (Falco, 2019; Ramdass & Zimmerman, 2008).

Collaboration and Peer Models

Collaboration and peer role models support students' self-efficacy by providing social persuasion, mastery experiences, and vicarious experiences (Alt, 2015; Schunk, 2012). Vicarious experiences from observing peers' success can positively affect the students' perceptions of their ability for the task at hand, especially those with low self-efficacy beliefs (Alt, 2015, p. 62; Schunk, 2012). Observing peer models increases self-efficacy beliefs more than teacher models (Schunk, 2012). Furthermore, collaborative interactions with peers lead to reflection, forming mastery experiences (Alt, 2015, pp. 62-63). Finally, when students share the strengths they see in their peers, the self-efficacy of all students involved in the collaboration can increase due to social persuasion (Alt, 2015; Schunk, 2012). Using this method allows students to see how peer models' effort, positivity, and confidence influence their self-efficacy.

Metacognition

Metacognition supports students' self-efficacy and achievement by increasing their reflective thinking on their ability, influencing how they interpret their ability (Alt, 2015; Colognesi et al., 2019). Research shows that increasing metacognitive practices, in which students engage in self-reflective thinking based on their teacher or peers' questioning, significantly increases self-efficacy (Alt, 2015; Colognesi et al., 2019). In a 2019 study, Colognesi et al. showed that, in their sample of 85 adolescent students, those who received metacognitive interventions show a statistically significant increase in self-efficacy beliefs compared with a control group based on a quantitative measure of students' self-efficacy beliefs. Furthermore, reflective metacognition, where a student examines their thinking related to their learning process, has more of an effect on self-efficacy than knowledge-based metacognition. Knowledge-based metacognition is reflective thinking focused on skills and knowledge acquired in an activity (Alt, 2015). Thus, teachers need to motivate students to think reflectively about the content material and their learning processes. This reflective thinking benefits students whether the metacognitive questioning comes from their teacher or peers (Colognesi et al., 2019).

Conclusion

This literature review introduces several methods to increase students' self-efficacy. These methods include project-based and self-paced learning, assignments and a learning environment that support self-regulation and metacognitive reflection on one's understanding, collaboration among girls, positive peer modeling, and use of role models. Based on this literature review's findings and the unprecedented educational situation caused by the 2020-201 COVID-19 pandemic, the intervention implemented is a peer-to-peer collaboration model. In this intervention, we pair students in a blended learning model to collaborate on the scientific concepts they are trying to master and reflect on their progression towards mastery. The researcher aims to find that this model significantly promotes positive social interaction and increased perceived beliefs in their abilities by offering positive vicarious experiences with science within a blended classroom environment.

Methodology

This study was performed as a participatory action research project. The main focus of the intervention was to analyze how student collaboration supported the growth of science self-efficacy when students were grouped together to work on concepts addressed within the normal classroom setting. These pairings of students included those working in the school classroom and those working remotely through Google Meets from home. In order to analyze the impacts of this peer collaboration, the researchers collected and analyzed both qualitative and quantitative data designed to measure science self-efficacy in the 8th-grade science classroom. The primary quantitative tool in this study was a pre-questionnaire and post-questionnaire using a Likert Scale to measure students' beliefs about their ability in science across five categories. In addition, students responded to an exit ticket in Google Forms twice a week for the duration of the intervention. Researchers used the exit ticket quantitatively to rate the students' understanding of the concepts. The exit ticket was also used as a qualitative measure because students were given an open-ended question to use as a reflective tool. The reflective question allowed researchers to find common themes students experienced during the peer-to-peer models and how the themes affected their confidence and understanding of the topic. An additional qualitative tool used in this study was an interview conducted through Flipgrid before and after the intervention. All students were asked to respond to a video journal and responses from a focus group were transcribed to give the researchers an understanding of how self-efficacy changed for students over the course of the intervention. Finally, the researchers each used a SciGirls Equitable and Culturally Responsive Teaching Rubric to determine their individual growth in self-efficacy in teaching practices during the course of the intervention.

The population for this action research study was 8th-grade science students from urban and suburban areas of Minnesota. The sample included 8 Earth Science classes that were at different times participating in a distance, hybrid, or in-school learning model during the 2020-2021 COVID-19 pandemic. Out of the eight classes of 8th-grade science students involved in the study, 111 students responded to both the pre-questionnaire and post-questionnaire. In the 111 responses, 53 were boys, and 58 were girls. Also, the respondents were 71 white students and 40 BIPOC students. Researchers chose a required course for the students in which they conducted their research. The sample represents the population at the research schools.

Table 1

Sample Demographics

Total Number of Students	Gender		Ethnicity	
	Male	Female	White	BIPOC
111	53	58	71	40

Researchers collected student and teacher self-reported data through the use of several instruments. At the beginning and end of the 6-week intervention, students completed a Science Self-Efficacy Questionnaire through Google Forms (see Appendix A) and Video Journal through Flipgrid (see Appendix B). Researchers adapted the questionnaire from Lin and Tsai's (2013) Multidimensional Students' Science Learning Self-Efficacy Survey. In the questionnaire, students were asked to self-evaluate their self-efficacy using a Likert scale from 1 (strongly disagree) to 6 (strongly agree) on the following categories: conceptual understanding, high-order cognitive skill, practical work, everyday application, and science communication. The questions used in the video journal were developed from Álvaro and Couso's (2018) STEAM4U

Measuring Toolkit. The content of these questions included students' beliefs about science in general, how they overcome difficulties in science, and their perceived viewpoints on gender differences in science. Students also completed exit tickets (see Appendix C) twice a week during the 6-week intervention, following peer collaboration-based lessons that had them identify the main idea of the lesson and the aspects of the peer collaboration that best aided their understanding. Lastly, both teacher-researchers completed a weekly rubric (see Appendix D) that analyzed their teaching strategies and self-efficacy. Anderson, Billington, Davis, and Santiago developed this rubric as part of a grant for National Science Foundation (NSF) Grant #1513060 and Twin Cities Public Television SciGirls (2019).

Before the intervention started, researchers sent a letter (see Appendix E) to parents and guardians informing them of this action research. At the same time, the researchers explained the action research to students, so they understood the intervention parameters using student-friendly language. To verify that the students understood, teachers also reviewed the main concepts of the intervention by completing a Kahoot, a digital multiple-choice game. Students were given the Science Self-Efficacy Questionnaire at the onset of the intervention through a link to a Google Form. The teachers read through each question to make sure students understood what the statement said. Students responded individually on their digital devices, ranking their self-efficacy regarding the question and analyzed. Researchers compared the results of this questionnaire with the results of the same questionnaire given at the end of the intervention. From the data collected from the questionnaire, researchers completed a t-test difference of means analysis and analyzed positive or negative growth in the five categories of the questionnaire.

In conjunction with the pre and post-questionnaire, students recorded video journal responses about their beliefs about science through Flipgrid and how they change through the course of the intervention. Students were limited to a maximum of five minutes to share their responses in a video to the journal questions posed. After students recorded their videos, the researchers transcribed what focus group students said and removed any personally identifying information. The researchers chose the focus group students to understand better how self-efficacy changed for students throughout the intervention. The selected students in the focus group were female, or black, indigenous, or people of color (BIPOC) and in the bottom 20% of the pre-assessment when possible so the researchers could gather meaningful data from students at the highest risk of low self-efficacy in science. Researchers used the information to determine critical themes, which were coded into several categories to determine frequency changes between the pre and post responses.

Throughout the six-week intervention, the researchers paired students with a peer with whom they worked on the scientific concepts addressed during the class period. Due to the changing environment of the 2020-2021 COVID pandemic, students varied in the location of their learning between being physically in the classroom and being digitally connected with the class and their peers through Google Meet. With their partner, students completed collaborative lessons at least twice a week. In these lessons, students worked with their assigned partners to learn and practice the skills behind the daily lesson for the majority of the class period. Towards the end of the lesson, students completed an exit ticket through Google Forms that asked them to do two things. Students shared the main idea of the lesson, which checked for student understanding of the daily learning targets set by each teacher. Also, students wrote about how working with their partners helped them comprehend the main ideas and their confidence in their work. The teachers tracked these exit tickets to determine if there was a growth in frequency of learning target mastery, noted collaboration skills, and self-reflection indicative of increased self-efficacy. Reported common themes shared as benefits of peer collaboration were documented by the researchers as well.

At the end of each week of the intervention, both teachers also assessed their science and teaching strategy self-efficacy by using the SciGirls Gender Equitable and Culturally Responsive Practices Rubric. Through weekly tracking, the researchers analyzed their growth in their teaching strategies and determined which areas of development they could continue to enhance through the intervention. The reasoning behind completing this was that by reflecting on their self-efficacy, the researchers would become more confident in their abilities, which would help students increase their science self-efficacy.

Overall, the researchers triangulated these instruments to assess what impacts peer collaboration has on 8th-graders' science self-efficacy. The researchers determined common themes and frequency to note changes in student belief through action research and used the findings to draw conclusions and make recommendations for further research and analysis.

Analysis of Data

The purpose of this study was to determine the effects, if any, that peer-to-peer collaboration had on student science self-efficacy, specifically in females and BIPOC. Students would complete exit tickets during six weeks, demonstrating what they learned and describing how the peer collaboration helped support their learning. Both qualitative and quantitative data were collected using a pre and post science self-efficacy questionnaire, video journal responses to questions of the student's science beliefs, bi-weekly exit tickets, and an equity and culturally responsive teaching rubric completed by each teacher in the intervention.

Students completed the pre and post science self-efficacy questionnaires at the beginning of the intervention period and upon completion of the intervention. Researchers collected data through a Google Form completed by students during class time. Researchers asked students to rate themselves on a scale of 1-6 from "strongly disagree" to "strongly agree" in response to 28 statements spanning five categories. These categories included conceptual understanding, high-order cognitive skills, practical work, everyday application, and science communication. At the end of the intervention, researchers removed personally identifiable information from the data. Students were assigned a number. Researchers included student gender and ethnicity with the data to analyze data according to categories of interest for the research questions. Researchers graphed results for the pre and post-questionnaires in box plots for visual comparisons and compared mean and median for the total score of the questionnaires and the different topical categories of the questionnaire. Also, researchers performed several statistical analyses on this data, including regular t-test, t-test paired difference and t-test difference of means. For all statistical analyses, the researchers used a significance level of $\alpha=0.05$ to test for significance.

The video journal responses were completed by students both at the onset and end of the six-week intervention. Researchers initially collected data through Flipgrid, in which students videotaped themselves verbally responding to 6 questions about their beliefs in science. All responses were 5 minutes or less in length. The researchers transcribed the student responses into text and separated the text by questions answered. In addition, researchers removed any personally identifiable information. Each student was given a number for the researchers to identify how they individually changed from their initial responses to their final answers. Researchers identified several discrete categories for the open-end questions based on student responses in the initial student responses from the beginning of the intervention from the transcript. Afterward, researchers placed all student responses in their corresponding categories. When responses covered more than one category, researchers duplicated the responses and put them in all the applicable categories. Researchers determined percentages of students who responded to each category from placement and formulated them into a table. The close-ended questions 2, 3, and 6 were tallied and sorted into whether the student answered “yes” or “no” to the question. Likewise, this data was computed based on the gender and ethnicity of the student who responded as well. The researchers then formulated the results of this information into a bar graph showing how responses changed from the initial journal response to the final journal response. Like the open-ended questions, the researchers also coded why students responded “yes” or “no” in several discrete categories for further analysis and shared common themes in a narrative.

Twice a week during the intervention, students completed a digital exit ticket through google forms. The data that researchers collected from this Google Form was imported by the researchers into a spreadsheet. After collecting the data, researchers removed any personally identifiable information and assigned each student a number. The researchers imported the data that researchers collected from this Google Form to track changes across individual students. From the open-ended question of asking students what the lesson’s central idea was, which checks to see if students were achieving the learning targets, researchers labeled each response as either yes or no. The ”yes” applied to students who corrected showed understanding of the daily lesson. The “no” applied to students who incorrectly or only partially showed knowledge of the daily lesson. The total number of yes and no responses for each week was then counted and put into a line graph to show changes in understanding from week to week. In addition to analyzing the information from the students as a whole, the researchers also categorized this data by gender, male or female, and ethnicity, white or BIPOC, and applied it to the same line graph. Using the second open-ended question, which asked students what pair of their pair work was most beneficial to them for the day, the researchers labeled each response as positive, neutral, or negative. Positive responses include those that share valuable ideas about their daily work. Neutral responses were either vague in explanation or did not relate clearly to the question researchers asked. Negative responses include disinterested or unhelpful aspects of the work for the day, such as “I don’t know” or “they didn’t talk.” These responses were counted weekly and then combined into a stacked column chart to show how the amount of each response changed throughout the intervention. Researchers also noted common themes shared by students in their responses in narrative form.

Throughout the intervention, both researchers self-assessed using the Sci Girl Rubric developed by Anderson, Billington, Davis, and Santiago in 2018. The researchers assessed their performance as educators at the end of each week across four major categories. The categories were gender/culturally equitable teaching strategies, professional responsibilities, classroom environment and social interactions, and classroom instruction preparation. Researchers scored the rubric using novice, proficient, and exemplary as categories. The researchers assigned these categories the values of 1, 2, and 3, respectively, to analyze the data quantitatively. Using the quantitative data generated from the rubric, researchers analyzed their growth through the six-week intervention in each category by calculating the average score from each category and plotting the average scores in a line chart. Likewise, researchers plotted each researcher's total score on the self-reported rubric in a line chart for the six-week intervention.

Findings

The purpose of this research study was to see what effect, if any, peer collaboration had on science self-efficacy in 8th-grade students, with a particular focus on female and BIPOC students. Researchers collected quantitative and qualitative data through pre and post-intervention questionnaires, student video journaling on Flipgrid, reflective exit ticket Google Forms, and a self-assessed culturally responsive teaching rubric.

Overall Science Self-Efficacy

At the onset and completion of the intervention, students completed a questionnaire that asked them to rate their beliefs about their ability in science by responding to several prompts. Students responded using a scale of "Strongly Disagree - 1" to "Strongly Agree - 6." Researchers compared student responses before and after the intervention in five categories (see Appendix A). Table 2 below shows the mean score overall and for each category before and after the intervention. Likewise, the researchers formulated the information into boxplots for each of the five categories to determine the medians for the questionnaire and determine if there were any outliers.

As seen in Table 2, the mean score for students in each category increased overall during the intervention. The overall score grew an average of 5.6 points or 4.9%. Each category also saw an increase in mean scores. Practical work and higher-order cognitive skills started with the highest means and grew the least, 2.0% and 2.9%, respectively. The everyday application had 4.9% growth. Conceptual understanding and science communication had the most growth; each category grew by 7.3% during the intervention.

Table 2

Student change in mean score overall as well as the five categories on the questionnaire before and after intervention

Category	Mean Before Intervention	Mean After Intervention	Change in Mean	Percent Change in Mean
Overall Score	114.2	119.8	+5.6	+4.9%
Conceptual Understanding	4.1	4.4	+0.3	+7.3%
High-Order Cognitive Skill	4.3	4.4	+0.1	+2.3%
Practical Work	4.9	5.0	+0.1	+2.0%
Everyday Application	4.1	4.3	+0.2	+4.9%
Science Communication	4.1	4.4	+0.3	+7.3%

Researchers performed further analysis on the questionnaire data, including creating box plots for before and after scores in each category and overall. Figures 1-6 are a collection of before and after boxplots of student reported scores on the questionnaire overall and each category.

The boxplots in Figures 1-6 show an increase in the median score for the overall score and all categories except practical work. In practical work, the median stayed the same from the beginning of the intervention to the end. However, the first quartile number and third quartile number have increased in the practical work category for the intervention. The first quartile went from 4.25 to 4.5, and the third quartile went from 5.5 to 5.75. In fact, for all categories and overall, the first quartile increased. In higher-order thinking skills, the third quartile remained the same before and after the intervention, but overall, it grew in all other categories. When comparing the pre-intervention boxplot to the post-intervention boxplot, there were changes to the interquartile range (IQR) for most categories. Overall the IQR increased from 28 in the pre-intervention questionnaire to 29.5 in the post-intervention questionnaire, indicating more of a spread in scores for the post-intervention questionnaire. For conceptual understanding and practical work, the IQR stayed the same, showing that for these categories, the range of scores stayed similar before and after the intervention. Higher-order cognitive skills, everyday understanding, and science communication all decreased IQR throughout the intervention indicating that student scores in those sections became more similar throughout the intervention.

Furthermore, the median's skewness inside the boxplot box changes for many questionnaire categories throughout the intervention. In the pre-intervention questionnaire, the overall score is skewed to the right, indicating a more considerable amount of variation in the scores of those students above the median. The boxplot shows even distribution after the intervention. This distribution suggests that students varied in their scores similarly above and below the median after the intervention. For conceptual understanding, the box plot shows a skew to the left before and after the intervention implying a broader range in scores below the median score than above it. The box plot shows a skew to the left before the intervention for the categories of higher-order cognitive skill, practical work, and everyday application. After the intervention, the box plot indicates a skew to the right. The skew shows a more extensive range of scores under the median before the intervention and a greater range of scores above the median. Finally, for science communication, the initial questionnaire has a boxplot that shows evenly distributed data. Still, the questionnaire at the end of the six-week intervention is skewed to the left, indicating a more significant range of scores below the median than above it after the intervention.

There were some outliers in the scores of the questionnaire overall and each category. For the total score, there is one outlier before and after the intervention. For the categories of conceptual understanding, higher-order cognitive skill, and everyday application, the number of outliers went down during the duration of the intervention. However, for practical work and science communication, the number of outliers increased at the end of the intervention. In all instances, outliers for the questionnaire were scores that were significantly lower than expected.

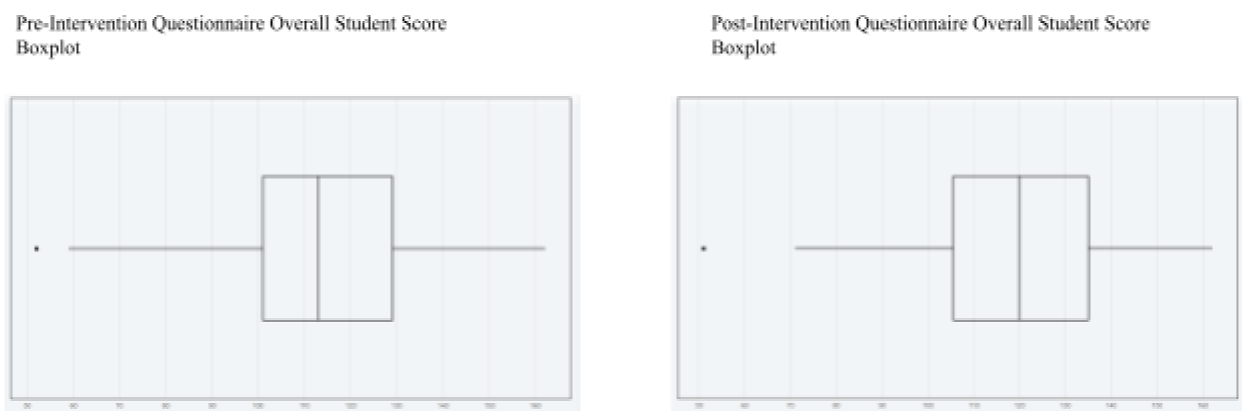


Figure 1. Boxplots of students reported scores on self-efficacy in science before and after the intervention as determined by a questionnaire.

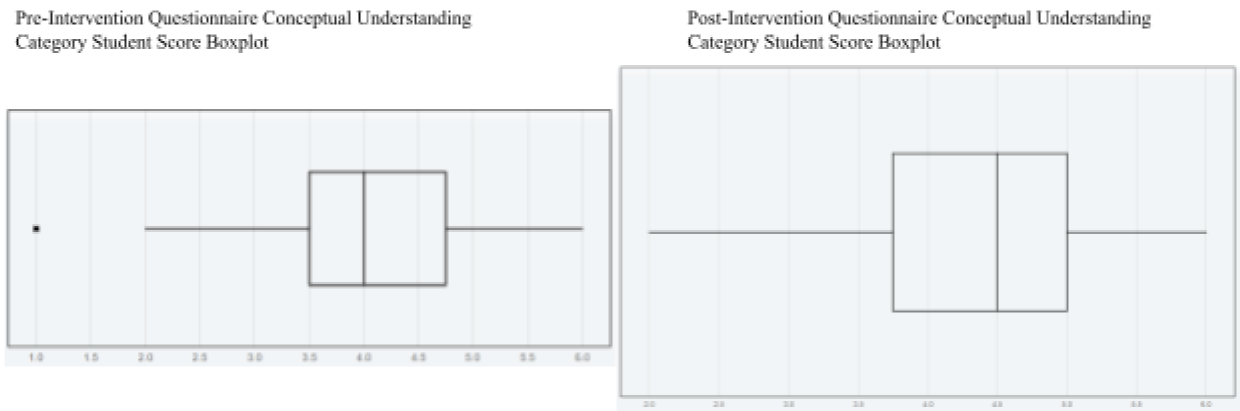


Figure 2. Boxplots of students reported scores on conceptual understanding in science before and after the intervention as determined by a questionnaire.

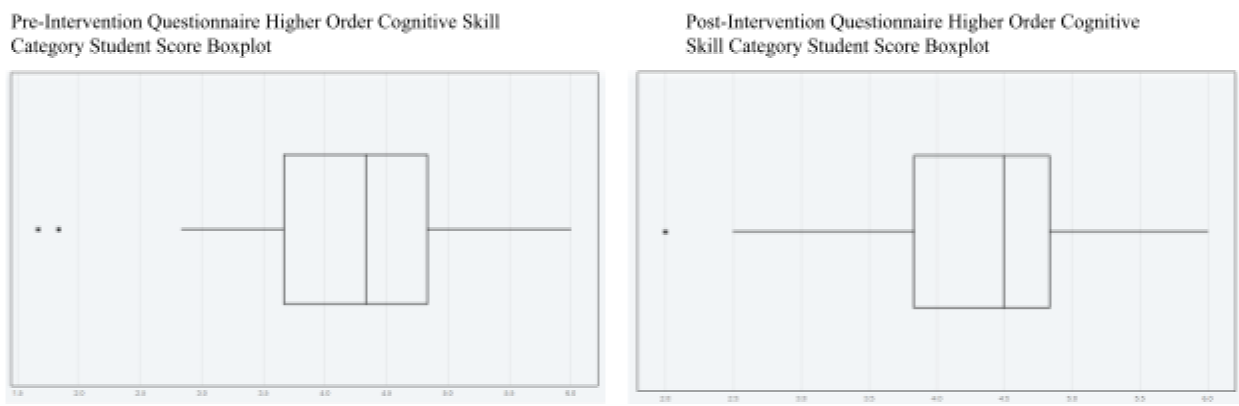


Figure 3. Boxplots of students reported scores on higher-order cognitive skills in science before and after the intervention as determined by a questionnaire.

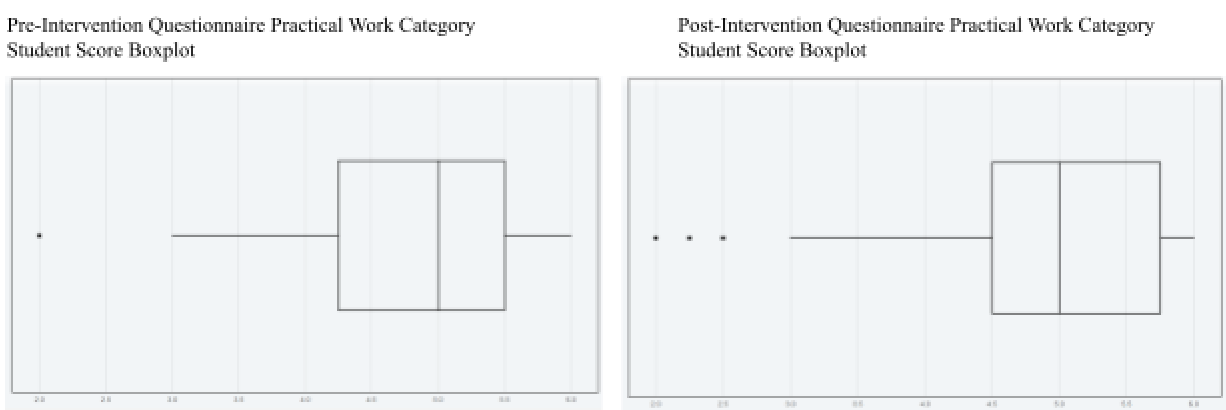


Figure 4. Boxplots of students reported scores on practical work in science before and after the intervention as determined by a questionnaire.

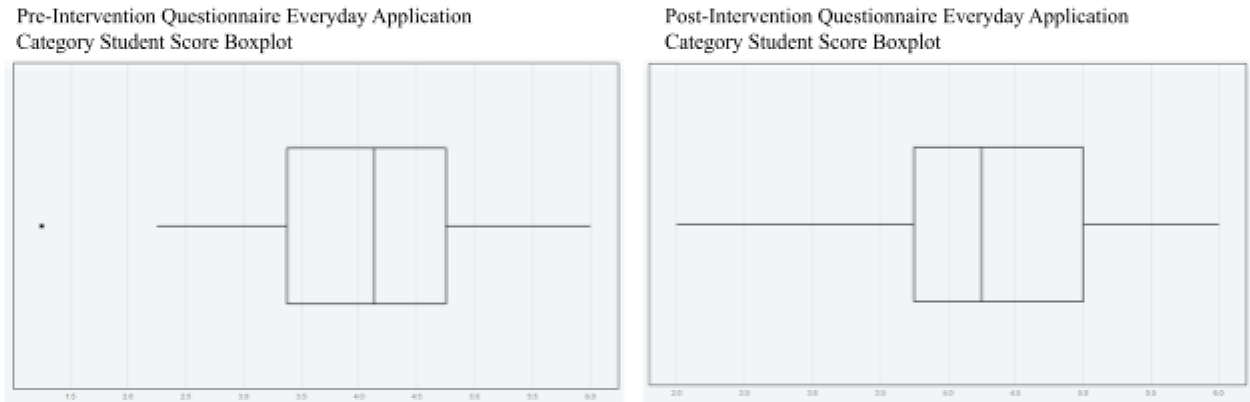


Figure 5. Boxplots of students reported scores on the everyday application in science before and after the intervention as determined by a questionnaire.

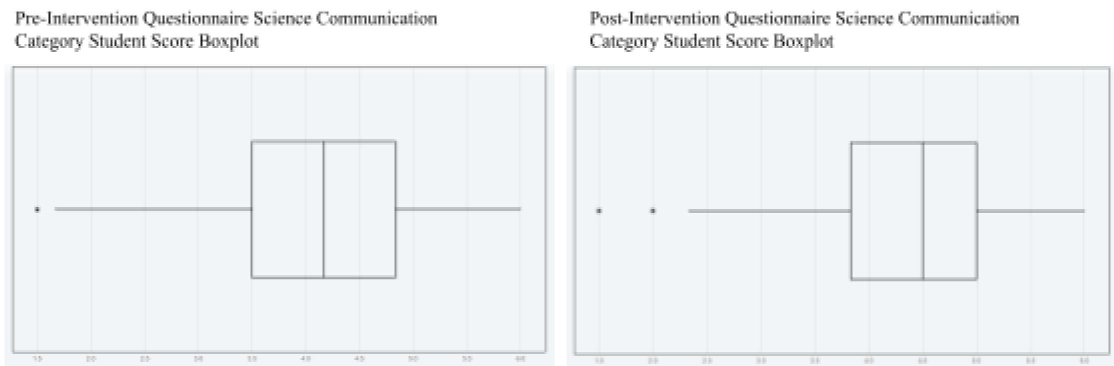


Figure 6. Boxplots of students reported scores on science communication before and after the intervention as determined by a questionnaire.

Researchers also analyzed the questionnaire data using a paired difference t-test to compare the pre and post-intervention scores. This test allowed the researchers to compare the scores from before and after the intervention to show a statistically significant increase in the students' self-efficacy. Table 3 shows results from that analysis.

As seen in Table 3, the p-value for this analysis was 0.000032. This p-value is below the significance level of $\alpha = 0.05$. Therefore, the researchers rejected the null hypothesis that the post-intervention scores would not differ from the pre-intervention scores. This data supports the alternative hypothesis that the post-intervention scores are significantly higher than the pre-intervention scores.

Table 3

Paired Difference t-test results comparing pre and post-intervention overall scores.

T-test - Paired Difference		
Hypotheses	Test	P-Value
H_0: $\bar{x}_{post} = \bar{x}_{pre}$ H_A: $\bar{x}_{post} > \bar{x}_{pre}$	$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}} = \frac{5.56}{\frac{14.07}{\sqrt{111}}} = 4.16$	p=0.000032

As part of determining how peer collaboration affected science self-efficacy, the students completed exit tickets at the end of the class period twice a week for six weeks. One of the questions that the students answered in the exit ticket were, “What part of today’s pair work did you feel best contributed to your confidence and understanding in scientific processes?” The researchers then coded the data from this open-ended question as a positive, neutral, or negative response. An increase in positive responses paired with a decrease in neutral and negative responses would indicate that working with peers positively impacted how comfortable and confident students felt working in the science classroom, a key component of building science self-efficacy.

As seen in Figure 7, as the six weeks progressed, negative and neutral responses decreased while positive responses increased. Between the first week, which had 24 negative responses, and the last week with six negative responses, the number of students who did not believe that peer collaboration was beneficial went down 15.92%. Common themes within the negative responses during the first three weeks were related to not liking working in groups (6), finding individual work more beneficial than group work (4), and being unsure of the purpose of group work (2). By the end of the intervention, the common theme of the negative responses that remained was that students wanted their peers to talk with them more (3). Neutral responses contain student feedback that was either vague such as “we worked well together” or focused on the activity or task they were working on with their peer rather than the skills used in the pair work. Between week one and week 6, the total number of neutral responses decreased by 7.67%.

On the other hand, positive responses increased from 70 in week 1 to 113 in week 6. Overall, positive responses increased by 24.90%. The most common themes shared in positive responses by the end of the intervention were being able to double-check work (12), having support when stuck (14), gaining confidence in thinking when peers agreed with you (6), and brainstorming together (3).

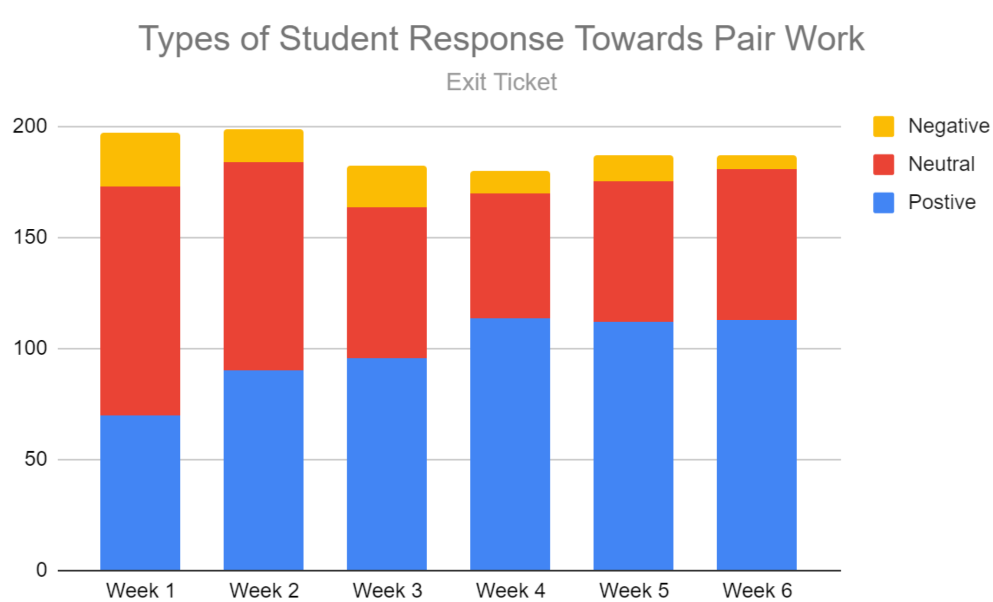


Figure 7. Student mindset towards peer collaboration as determined by their open-ended responses to the benefits of working with each other over six weeks.

Most Vulnerable Groups

Though the intervention used in this research study showed an increase in self-efficacy overall, researchers wanted to pay special attention to groups historically underrepresented in science fields. Therefore, researchers analyzed data specifically comparing the pre and post-intervention questionnaire responses from female students, BIPOC students, and the intersectional group of female BIPOC students. Table 4 shows data about these groups, including pre and post-intervention mean scores overall and in each category for the questionnaire, as well as results from a paired difference t-test for each identified vulnerable group.

Table 4 shows an increase in average scores for all learners in the identified vulnerable groups of female students, BIPOC students, and female BIPOC students. Not only is there an increase in overall scores on the questionnaire from before and after the intervention, but there is also an increase in the average response score for each category. All vulnerable groups saw the most significant average growth in the science communication section of the questionnaire. For female students and BIPOC students, the second-largest growth area is in the conceptual understanding section of the questionnaire. On the other hand, female BIPOC students had the second-largest growth area in the practical work section of the questionnaire. Growth is evident for all vulnerable groups on the questionnaire scores.

To verify the increase was significant, researchers ran a paired difference t-test on the overall scores for the vulnerable groups. For each group, the null hypothesis was that there was no significant change in scores before and after the intervention. The alternate hypothesis for these tests was that the post-intervention questionnaire score was significantly higher than the pre-intervention scores. For female students, with an average increase of 6.1 points on the questionnaire, the t-score was 3.87, which gives a p-value of 0.000141, which is significant at a level of $\alpha = 0.005$. So researchers rejected the null hypothesis because the data support the alternate hypothesis. For BIPOC students, the average score on the questionnaire increased by 5.1 over the six-week intervention, giving a t-score of 2.44 and a p-value of 0.0095, which is also significant at a level of $\alpha = 0.005$. Also, for BIPOC students, researchers rejected the null hypothesis and supported the alternate hypothesis. However, for female BIPOC students, the average increase in score on the questionnaire was 4.5, which gave a t-score of 1.68 and a p-value of 0.0535, which is not significant at a level of $\alpha = 0.005$. Because the p-value of this analysis for female BIPOC students is too high, researchers did not reject the null hypothesis because there is a chance that the increase in the overall score for the female BIPOC students is due to random chance.

Table 4

Comparative data for pre and post-intervention questionnaire results for female, BIPOC, and female BIPOC students.

Female Students						
Section	Overall	CU	HOC	PW	EA	SC
Pre Intervention	113.5	3.97	4.27	4.90	4.05	4.07
Post Intervention	119.6	4.31	4.32	5.06	4.24	4.47
Change	6.1	0.34	0.05	0.16	0.19	0.40
Hypotheses		Test			P-Value	

Hypotheses	Test	P-Value
$H_0: \bar{x}_{postf} = \bar{x}_{pref}$ $H_A: \bar{x}_{postf} > \bar{x}_{pref}$	$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}} = \frac{6.08}{\frac{11.98}{\sqrt{58}}} = 3.$	p=0.000141 Significant at α = 0.005

BIPOC Students

Section	Overall	CU	HOC	PW	EA	SC
Pre Intervention	109.4	3.87	4.16	4.60	3.95	3.89
Post Intervention	114.5	4.12	4.26	4.73	4.12	4.18
Change	5.1	0.25	0.10	0.13	0.17	0.29

Hypotheses	Test	P-Value
$H_0: \bar{x}_{postB} = \bar{x}_{preB}$ $H_A: \bar{x}_{postB} > \bar{x}_{preB}$	$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}} = \frac{5.10}{\frac{13.35}{\sqrt{41}}} = 2.$	p=0.0095 Significant at α = 0.005

Female BIPOC Students

Section	Overall	CU	HOC	PW	EA	SC
Pre Intervention	109.2	3.88	4.14	4.61	3.90	3.92
Post Intervention	113.7	4.06	4.21	4.85	4.01	4.23
Change	4.5	0.18	0.07	0.24	0.11	0.31

Hypotheses	Test	P-Value
$H_0: \bar{x}_{postfB} = \bar{x}_{prefB}$ $H_A: \bar{x}_{postfB} > \bar{x}_{prefB}$	$t = \frac{\bar{d}}{\frac{s_d}{\sqrt{n}}} = \frac{4.54}{\frac{13.27}{\sqrt{24}}} = 1.$	p=0.0535 Not significant at α = 0.005

**Sections of the questionnaire included Conceptual Understanding (CU), High-Order Cognitive Skill (HOC), Practical Work (PW), Everyday Application (EA), and Science Communication (SC)*

As well as examining the effectiveness of the intervention on female and BIPOC students, the researchers chose a representative group of students and examined their pre and post-intervention self-efficacy questionnaire scores. The focus group students were selected to represent various students, males, females, and white and BIPOC students. All focus group students completed the pre and post-questionnaires, participated in the Flipgrid video journals, and completed at least two-thirds of the self-reflection Google Forms during the intervention. Researchers analyzed data about this focus group quantitatively and qualitatively. The primary sources of quantitative data for the focus group were the differences in average question scores before and after intervention on the questionnaire, overall score change, and a t-test paired difference test. Table 5 shows the difference in average response scores before and after the intervention.

In Table 5, researchers have documented how all students in the focus group increased average score on questions in the pre and post intervention questionnaire. All students in the focus group showed an increase in these scores for the intervention. The smallest increase was an increase of 3.6% for student 38. Student 21 had the largest increase in average question score with a 24.0% increase in average question score. The amount of growth varies for students across many categories. There does not seem to be a correlation in the focus group of large increases with initial low or high scores, gender, or ethnicity. The scores for the focus group students were further analyzed by comparing the overall score before and after intervention and by completing a paired difference t-test. Researchers chose to study the change in focus group scores using a paired difference t-test to seek evidence of a significant increase in overall score on the questionnaire for the focus group.

Table 5

Focus Group Differences in Averages Between Pre and Post Science Self-Efficacy Questionnaire

Student #	Pre Average	Post Average	Difference in Averages
21	2.71	3.36	+0.65
38	3.86	4.00	+0.14
39	4.36	5.00	+0.64
87	5.14	5.39	+0.25
109	3.00	3.46	+0.46
140	3.36	3.75	+0.39

Note. Students self-reported on the following scale: Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1)

**Student names were removed and replaced with a number*

*** Focus group students were chosen to reflect a balance between male, female, white, and BIPOC students*

Table 6 shows the change in overall score as well as the results of the paired difference t-test. As seen in Table 6, all students in the focus group had an overall increase in score from the onset of the intervention to the end of the intervention. The average increase in score for this group was 11.83 points over the intervention. The t-score for this test of 5.08 gives a p-value of 0.0019, which is significant for a value of $\alpha = 0.005$. This significance leads the researchers to reject the null hypothesis that there is no significant difference between pre and post-intervention scores for the focus group. Researchers have found that the alternative hypothesis, which states that the post-intervention scores for the focus group would be higher than the pre-intervention scores, is supported by the data.

Table 6

Comparative data for pre and post-intervention questionnaire results for focus group students.

Focus Group						
Student #	21	38	39	87	109	140
Pre Intervention	76	108	122	144	84	94
Post Intervention	94	112	140	151	97	105
Change	18	4	18	7	3	11

Hypotheses	Test	P-Value
$H_0: \overline{x}_{postfoc} = \overline{x}_{prefoc}$ $H_A: \overline{x}_{postfoc} > \overline{x}_{prefioc}$	$t = \frac{\overline{d}}{\frac{s_d}{\sqrt{n}}} = \frac{11.83}{\frac{5.71}{\sqrt{6}}} = 5.$	p=0.0019 Significant at α = 0.005

**Sections of the questionnaire included Conceptual Understanding (CU), High-Order Cognitive Skill (HOC), Practical Work (PW), Everyday Application (EA), and Science Communication (SC)*

In addition to analyzing the quantitative data of the focus group, the researchers also looked at how the qualitative data changed with the 6 chosen students. The key tools to analyze this data were the changes in the student's open-ended responses to their video journals. The researchers took the direct quotes that reflected each student's self-reported beliefs in their self-efficacy at the beginning and end of the intervention (see Appendix F).

Appendix F shows how the focus students self-reported in their ability to do science. At the intervention's onset, 3 of the students did not see themselves as scientists, while the other three thought that they could sometimes be scientists when doing labs. Similarly, 3 students did not feel capable of doing science, 1 student thought they were sometimes capable of doing science, and 2 thought they were capable of doing science. Of the two that thought they were confident, Student 87 showed confidence due to being fully engaged in the material, while Student 109 was less confident in their current ability. Instead, Student 109 had confidence in their future ability. The most common theme behind the lack of self-efficacy is that science is hard to understand and do. At the end of the 6 weeks, all students showed progression in their science self-efficacy, as indicated in their responses. While 4 students still did not fully see themselves as scientists, 3 focus group students focused on feeling more like a scientist. Only student 21 did not see themselves as a scientist at all because of a lack of interest in the subject. In terms of feeling capable of doing science, all students did improve in their confidence in their abilities. Even those who still saw science as hard, such as Student 21, 109, and 140, focus on overcoming their struggles to see success.

Student Achievement

As a part of determining the effects peer-to-peer collaboration has on 8th-grade science students, it was also essential to see if increases in science self-efficacy also lead to academic achievement gains. Previous research from the literature review has stated a strong correlation between self-efficacy and academic achievement (Lodewyk & Winnie, 2005; Schunk, 2012). To confirm this correlation, students answered the question, "In 1-2 sentences, explain what the main idea(s) of today's lesson was. In other words, what did you learn?" as part of the exit tickets, they completed twice each week. The researchers determined if each student had correctly or incorrectly shown understanding of the lesson's learning target from the data collected. This information was counted and sorted by gender and ethnicity to track changes in responses throughout the 6-week intervention. The figures below show the changes that occurred.

Throughout the intervention, the trend of students showing achievement in daily learning increased as the number of students who did not comprehend the main ideas decreased, as seen in Figure 8. At the onset of the invention, week 1, the gap between student understanding was narrow, with a difference of 10 responses. The gap grew in week 2, with a difference of 58 responses between those who showed understanding and those who did not. When gaps increase, it shows student growth in academic achievement and highlights a positive correlation between science self-efficacy and academic achievement. A similar trend continued in weeks 4 and 5. The difference between the yeses and noes was 83 in week 4 and 107 in week 5. On the other hand, both weeks 3 and 6 show a decrease in understanding. Week 3 only had a gap of 47 responses, down 11 responses from the previous week. Between week 5 and week 6, the downward trend was much smaller at a decrease of 7 responses. One contributing factor to these decreases may have been a large decrease in the total number of responses from students during both weeks due to confounding variables such as student absences. Likewise, by week 6, students may have begun to experience response fatigue in filling out the bi-weekly exit ticket.

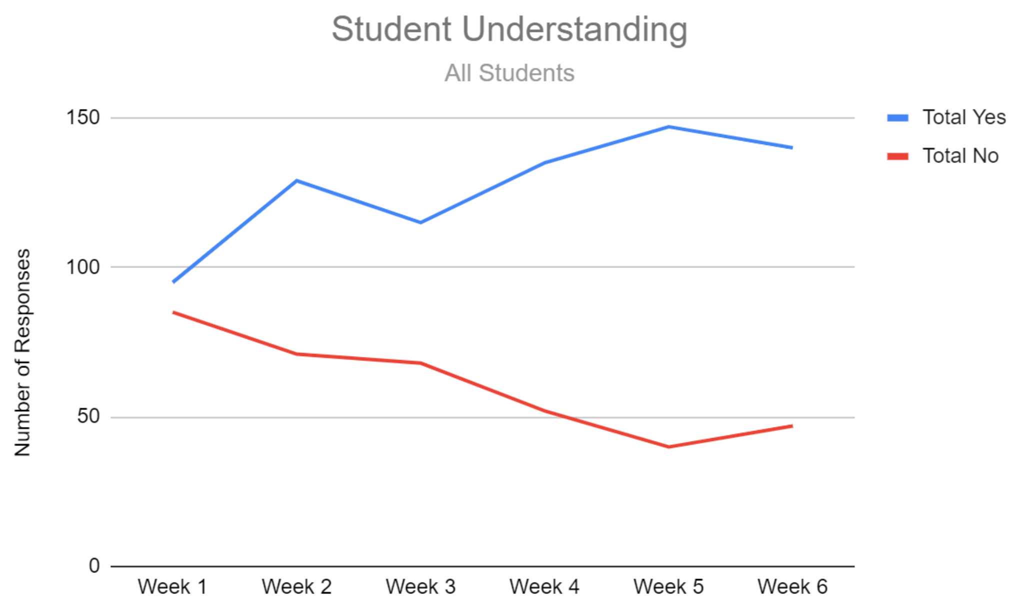


Figure 8. Overall student understanding of daily learning targets for 6 weeks.

Figure 9 represents the changes as compared between male and female students during the 6-week intervention. Both male and female groups show similar trends as the whole group's answers to the bi-weekly exit tickets. However, female students showed a greater overall improvement when compared to male students. In week 1, female students had more responses that did not show mastery of the learning target than those who understood the main idea of the lesson. Through the rest of the weeks, females show a greater change in their understanding of the learning targets, representing the largest gap between correct and incorrect responses during week 5. The gap was a difference of 52 responses. As a percentage of growth, female understanding increased by 44.83%. These changes indicate that peer collaboration has a strong positive effect on the self-efficacy and achievement of female students. Therefore, peer collaboration can support female students, a group who historically has been underrepresented in science (source). While not as strong as the female student growth, improvements in the responses of males show that the intervention was still effective in supporting their understanding and self-efficacy. When comparing the gap during week 1 with week 6, the overall positive responses were 41 or 38.68%.

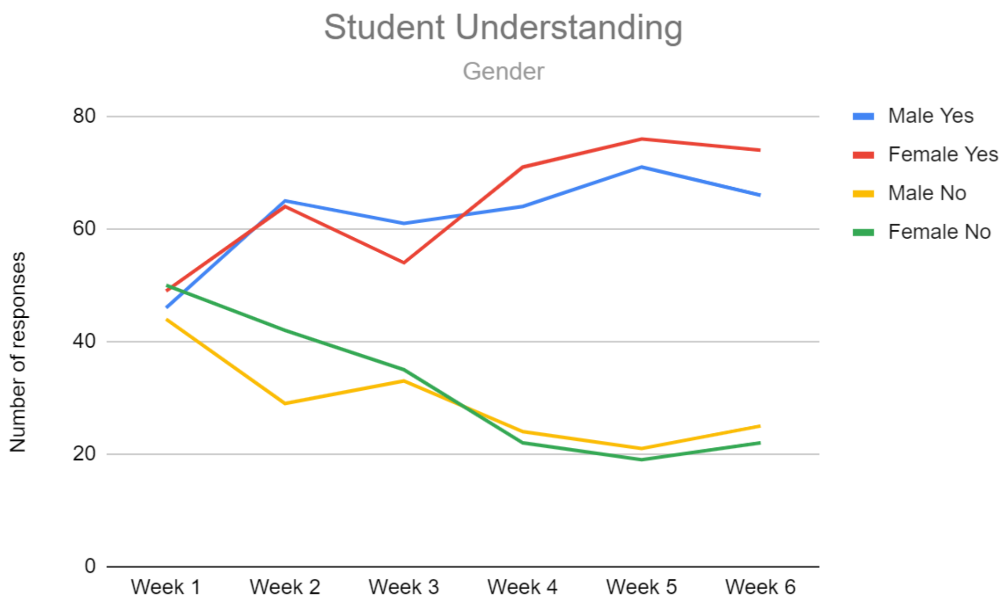


Figure 9. The weekly total correct and incorrect responses to daily learning targets as grouped based on gender.

When examining Figure 10 by ethnicity, there is a stark difference between the starting points for white students and BIPOC students. Even in week 1, white students have a gap of 7 between those who understood the lesson's main idea and those who did not understand it. In contrast, 3 more students did not understand the main idea than those who did understand it. As the weeks progressed, the gap between correct and incorrect responses grew for both groups. However, there is more growth in white students than with BIPOC, who are a more vulnerable group. The greatest growth for white students is seen between weeks 3 and 5 when the number of yeses steadily increased while the number of noes decreases. The largest difference between each was 70 responses in week 5. When accounting for sample size, this would represent a 49.30% growth in student understanding. The growth for BIPOC was much smaller in size, perhaps partly due to the smaller sample size. At its peak in week 5, the difference between correct and incorrect responses was 37 responses. This difference correlates to a student understanding growth of 46.25%.

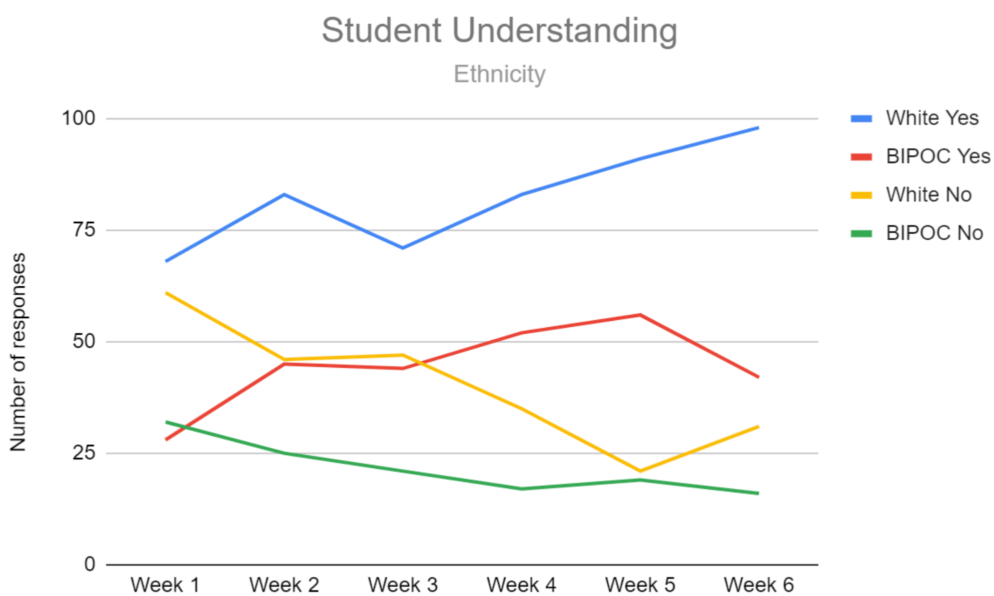


Figure 10. The weekly total correct and incorrect responses to daily learning targets as grouped based on ethnicity.

Student Viewpoints on Their Science Self-Efficacy

To determine the qualitative values of the student's science self-efficacy, the students completed two video journal responses. At the beginning of the intervention, students completed the first video response to establish a baseline on how students perceived their self-efficacy. The second was given at the end of the intervention to see how using peer collaboration increased how they view their self-efficacy. In both, students were asked the same 6 questions (see

Appendix B). After the intervention, the researchers transcribed the video responses and coded them into 8-9 distinct categories for each open-ended question and grouped them into responses on the closed-ended questions.

As a result, between the initial and final responses to the question "What does science mean to you?" the answers became more complex. As seen in Table 7, the majority of the responses in the initial video journal talked about how science was something that you learned, as demonstrated in the common theme "understanding scientific concepts, science literacy." For example, a typical response was similar to Student 14, who said, " Knowing science means that you understand the stuff and develop your own theories."At the final video journal response, this theme was still the most common response in the last video journal. The percentage who responded this way decreased by 4.06%. This change led to an increase in more complex ideas seen in the themes "knowing how things work," " application of science to everyday life," and "solving problems using science skills and processes." These three themes show that students better understand the relevance of science beyond the basics of learning. For example, Student 5 said, "I think it's really important to know how things work and what science means to me is having an understanding of how things work and why things are the way that they are."

Table 7

Video Journal Responses: Common Themes on the Meaning of Science for Students

What does doing or knowing science mean to you?		
Common Themes	***Pre-Intervention***	***Post-Intervention***
Understanding concepts in science, scientific literacy	27.03%	22.97%
Knowing how things work	18.92%	20.27%

Application of science to everyday life	12.16%	20.27%
Solving problems using science skills and processes	10.81%	13.51%
Doing experiments	9.46%	12.16%
Connecting the past, present, and future	8.11%	0%
Having confidence, science self-efficacy	5.41%	5.41%
Science is fun	4.01%	5.41%
Science does not matter	4.01%	0%

Figure 11 shows how student self-perception changed between the initial and final journal responses. Breaking it down by groups, all groups except for BIPOC students showed an increase in the number of students who saw themselves as scientists. Overall, the student growth in seeing themselves as scientists increased by 25%. The most common themes behind this growth were the idea that students had a greater knowledge of what science was, more confidence in their abilities, and the ability to help how things work. The largest growth occurred with white students, changing from 41% to 79%, increasing 38%. Between male and female students, the growth in those seeing themselves as scientists increased by 26% in both groups. BIPOC students had a 7% decrease. This decrease accounted for one student who had changed their mind on their viewpoint due to a change in their definition of what it is to be a scientist rather than a decrease in the confidence in their abilities as a scientist. Likewise, 4 of the students who responded that they still didn’t feel like a scientist noted confidence in making progress towards becoming a scientist in the future, showing less negativity than changing their initial responses.

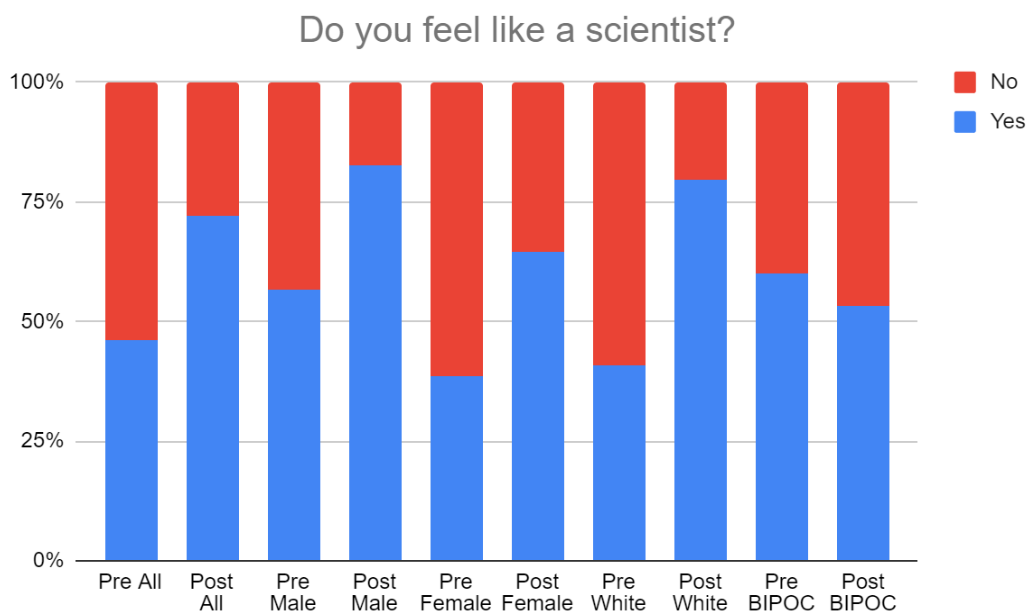


Figure 11. Student video journal response to whether they feel like a scientist from the beginning and end of the intervention.

As seen in Figure 12, even at the onset of the intervention, most students saw themselves as capable of doing science. Despite these large initial baselines, all groups continued to show growth in their capability beliefs. As a whole, the number of students who view them as capable increased by 22%. With an increase of 24%, female students showed the largest increase in their confidence in being capable of science. Male students showed the lowest percentage of growth at 7%. However, it is key to note that this group also had the highest initial percentage that felt capable of doing science. Change between white and BIPOC students was similar, with white students showing 20% growth from their initial response to their post responses. BIPOC students showed 19% growth in feeling capable. Some of the most common reasons shared for changes in student belief included 14 students who stated that their change was due to having more knowledge, 10 students who thought they had obtained more skills to support their abilities, and 7 students who noted that having more support in the teacher and peers increased their confidence in their abilities. For example, Student 32 said," I do feel capable of doing science now because having a group really helps me when I am facing a challenge or difficulty. I can ask them instead of stopping. That's why I can just ask somebody right next to me or that I'm doing the material with if they understand if they could help me."

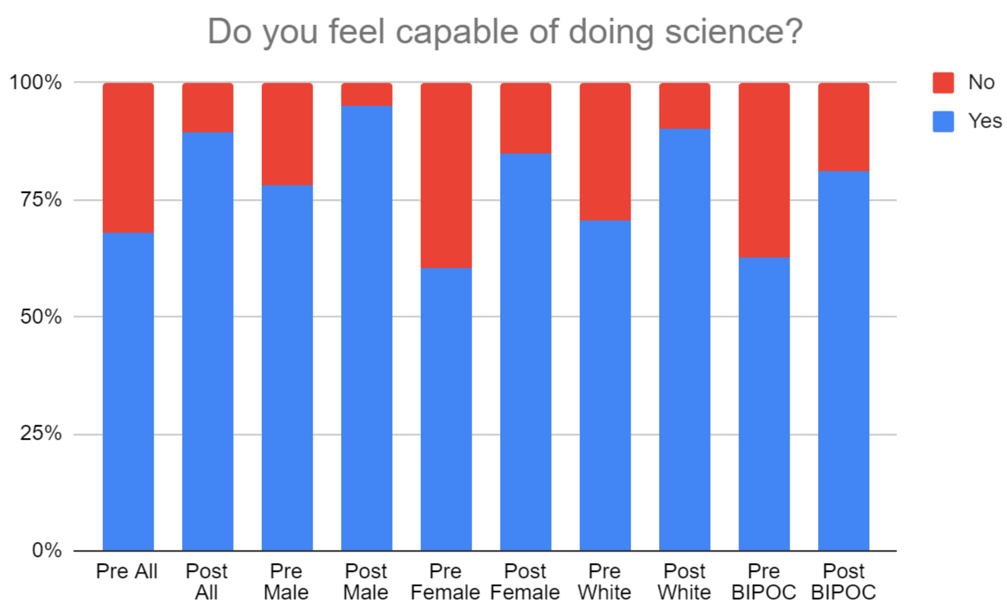


Figure 12. Student responses to their capability in science from the onset and end of the intervention as answered in the video journal responses.

Table 8 shows students' self-reported beliefs on the best ways they can overcome struggles in science. In their initial responses, the most common response was to find support by asking a peer or teacher for help. This theme continued to be the most common response at the end of the intervention, increasing by 6.46%. This increase correlates with the idea that students saw the benefit of collaboration and communication in science. Another attribute to note is that between the initial and final responses, students who get frustrated and give up when things get challenging in science decreased by 5.50%. As a result, more students found more methods to overcome struggles, increasing their belief in science self-efficacy.

Table 8

Video Journal Responses: Common Themes on How Students Persevere

When you face a challenge or difficulty in science, how do you act?		
Common Themes	***Pre-Intervention***	***Post-Intervention***
Ask a peer or teacher for help	26.87%	33.33%
Think it through, step by step	23.88%	19.75%
Change/Keep a positive mindset	17.91%	8.64%
Use resources such as notes, textbooks, or the internet	14.92%	8.64%
Try multiple times and ways to solve it, perseverance	13.43%	13.58%
Get frustrated and give up	10.44%	4.94%
Review the directions or posed challenge	8.96%	7.71%
Review their prior knowledge on the topic	8.96%	3.70%

Table 9 differentiates how students get support in science based on the intervention. Before the invention, students reported equally that understanding the lesson’s relevance, teacher instruction, and having resources such as notes and visuals aids were vital in determining their ability to be successful in science. By the end of the intervention, this changed as students became more dependent on communication and each other. The need for teacher instruction decreased by 1.78%, showing that students became less dependent on the teacher for learning. On the other hand, communication and working with peers increased by 16.73%, showing that students saw each other as capable of understanding and explaining scientific concepts. Using resources also increased between the beginning and end of the intervention by 7.45%. This increase correlates with supporting group work to aid their conversations as groups and pairs worked to understand the lesson's main ideas.

Table 9

Video Journal Responses: Common Themes About What Support Students in Science

What helps you do science?		
Common Themes	***Pre-Intervention***	***Post-Intervention***
Knowing the "why" behind the lesson	15.63%	9.23%
Teacher help and instruction	15.63%	13.85%
Resources such as notes, visual aids, videos	15.63%	23.08%
Reviewing previously learned content	14.07%	10.77%
Communicating and working with peers	12.50%	29.23%
Doing hands-on activities and experiments	10.94%	3.08%
Having a positive learning environment	6.25%	6.15%
Having self-efficacy	6.25%	3.08%
Learning assignments and tasks	3.13%	4.62%

Figure 14 shows how perceptions changed throughout the intervention when addressing student perceived differences based on gender in science. In the initial journal responses, only 22% of students believed that gender played a role in science. This belief continued to decrease by the end of the invention, with 15% thinking that there was a difference. The group which changed the view the most was male students, with 13% changing from thinking that there were gender differences to there not being any difference based on gender. The most consistent group between the initial and final video journal responses were female students, initial with only a 3% change. The most common themes in students sharing why they thought there were no gender differences include 10 students who believed that all genders are equally capable, and 19 students believed that difference occurs based on an individual's abilities and motivation rather than their gender. In contrast, with initial students who did think there were gender differences, common themes included the idea that middle school males have less focus and maturity (7 students responded this way) and females are less likely to interact with gross material (2 students responded this way).

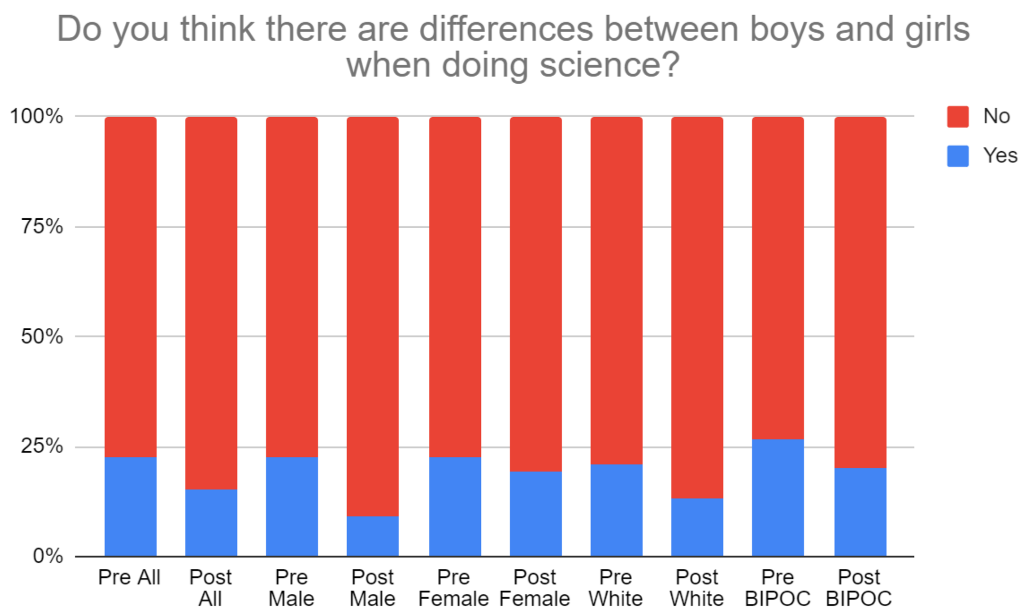


Figure 14. Student self-reported beliefs on whether gender makes a difference in science from the initial and final video responses.

Teacher Support of Student Self-Efficacy

Throughout the intervention, the teacher-researchers evaluated themselves each week using a rubric developed for Sci-Girls. The researchers monitored the change in their response as a measure of teacher self-efficacy. Figures 15-19 show the scores on the rubric overall and for each section of the rubric throughout the six-week intervention.

Figures 15-19 show an overall increase in researchers' scores on the rubric and an increase in each category of the rubric. Researcher 1 increased their score from 17 points to 24 points, an increase of 7 points or 41.2%. Researcher 2 increased their score from 26.5 points to 37 points, a rise of 10.5 points or 39.7%. Both researchers showed a large amount of growth on this rubric. For researcher 1, the largest growth area was in self-reflection; they increased 1 point in that section. For researcher 2, the biggest increase was in the classroom environment and social interactions; they increased an average of 0.8 points in that section. Researcher 1 showed the least growth in gender/culturally equitable teaching strategies, and Researcher 2 showed the least growth in self-reflection.

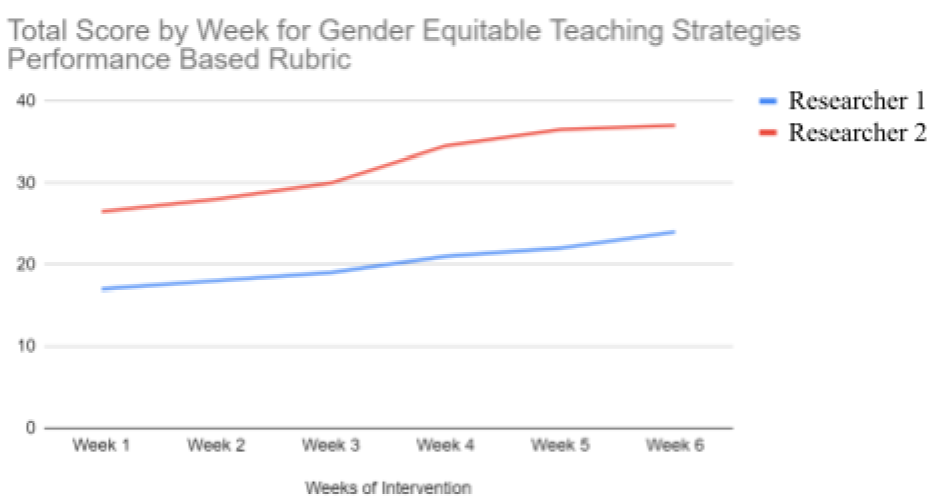


Figure 15. Total self-reported score on Sci Girls rubric for researchers 1 and 2 throughout the six week intervention.

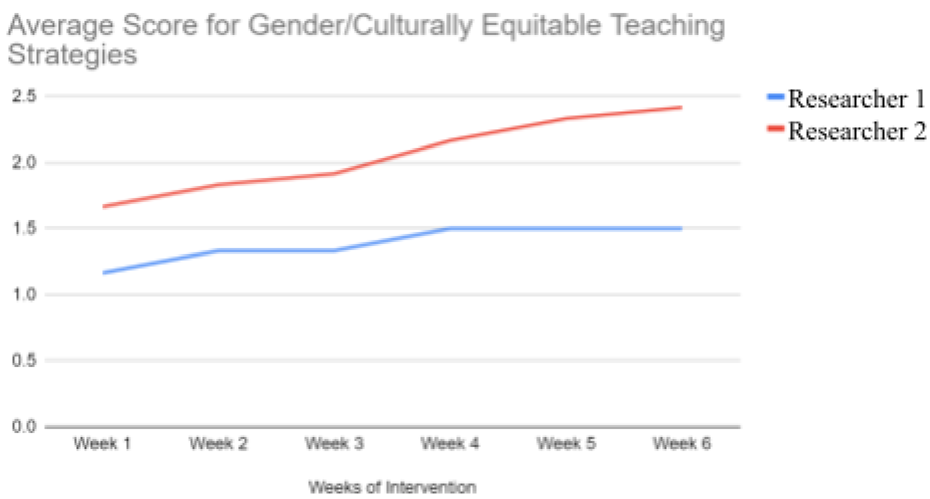


Figure 16. Average self-reported score on Gender/Culturally Equitable Teaching Strategies section Sci Girls rubric for researchers 1 and 2 throughout the six-week intervention.

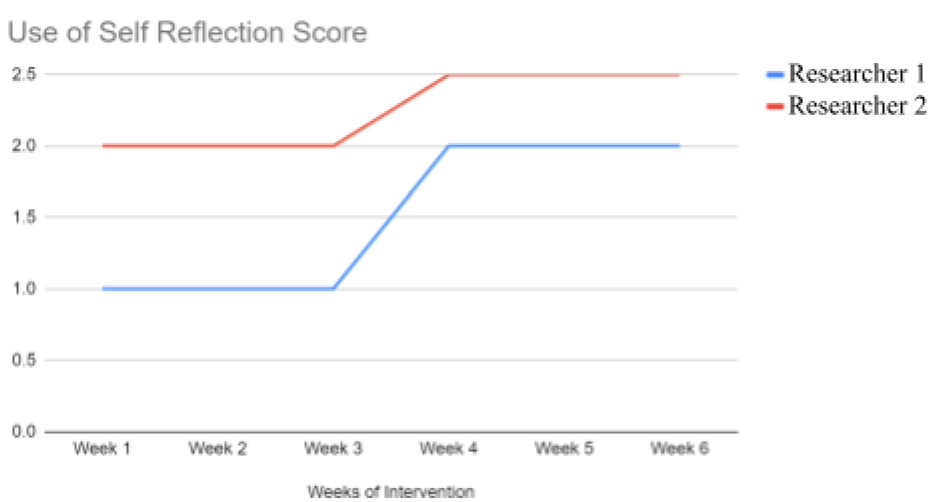


Figure 17. Use of self-reflection self-reported section score on Sci Girls rubric for researchers 1 and 2 throughout the six week intervention.

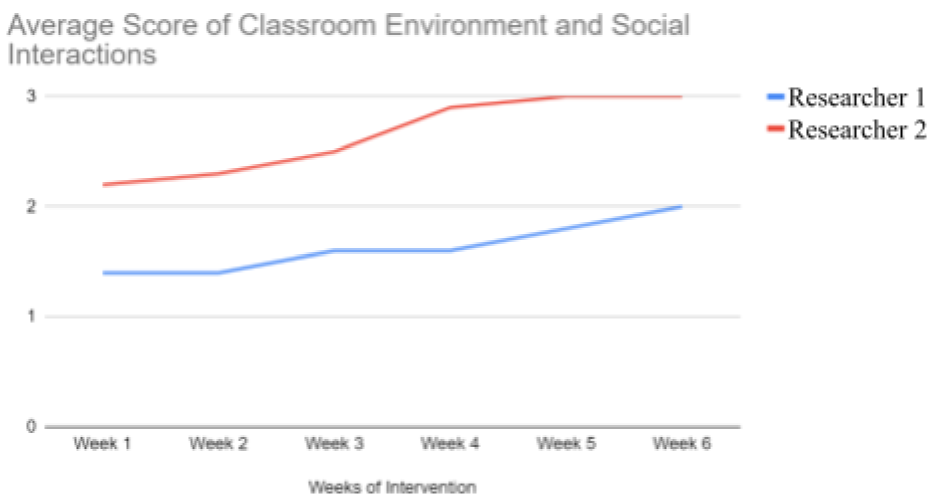


Figure 18. Average self-reported score on Classroom Environment and Social Interactions Section of Sci Girls rubric for researchers 1 and 2 throughout the six-week intervention.

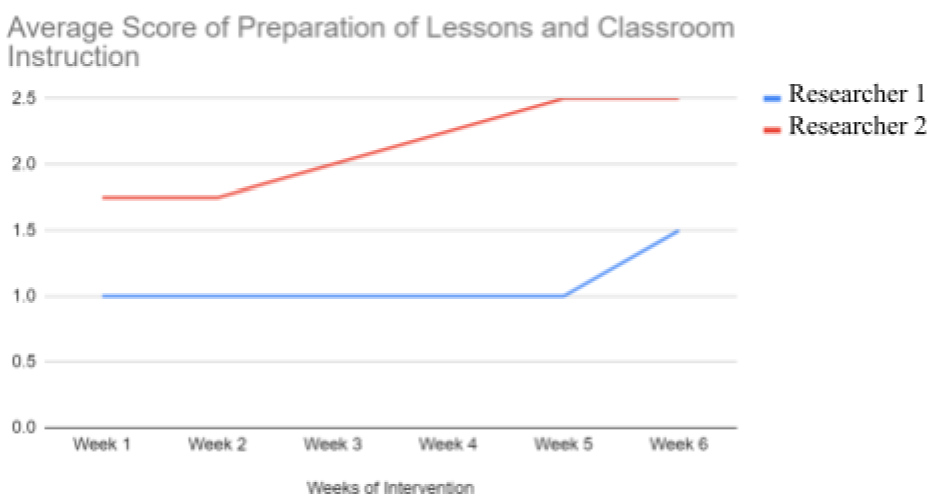


Figure 19. Average self-reported score on Preparation of lessons and classroom instruction for Sci Girls rubric for researchers 1 and 2 throughout the six-week intervention.

Overall, the 6-week intervention showed that peer to peer collaboration was significant in improving science self-efficacy in students. Likewise, all groups of vulnerable students showed growth; however, female BIPOC students could not establish the results as significant using the paired difference t-test. Qualitative results indicated that common themes students experienced in working in groups included growth in communication skills, a deeper understanding of scientific knowledge and the ability to use it, and increases in perseverance when struggling with a challenge. In addition, students showed an increase in seeing themselves as scientists and feel capable of doing science. Finally, teacher reflection showed gains in their science self-efficacy through their teaching strategies, classroom environment, and preparation of lesson plans.

Action Plan

The purpose of this study was to determine what effect peer collaboration had on the self-efficacy of 8th-grade science students. Researchers asked, "What impacts, if any, does a peer-to-peer model of instruction have on science self-efficacy in adolescents doing a hybrid learning experience?" Students were paired for work throughout six weeks and asked to reflect on their work and experience with their peers twice a week in an exit ticket. The intervention was bookended by students responding to a self-efficacy questionnaire and answering six questions in a video journal. Researchers collected data from exit tickets, questionnaires, and video journals. Then, researchers analyzed the data qualitatively and quantitatively.

The analysis revealed several essential pieces of information. Student self-efficacy increased by a statistically significant amount on average for the entire study group during the intervention. When analyzed independently, vulnerable groups of students such as female students and BIPOC students also showed significant growth in their self-efficacy beliefs as measured by the self-efficacy questionnaire. Female students had the most significant increase in self-efficacy during the intervention. However, though present, female BIPOC student growth was not statistically significant at a significance level of $\alpha = 0.05$. Analysis of student content understanding as measured by students identifying the main idea of lessons in one to two sentences on exit tickets twice a week showed increases for the whole sample and female and BIPOC students.

In addition, qualitative and quantitative analysis of student responses in their video journals shows that, on average, students report an increase in their ability to do science and their feeling of being a scientist. This increase holds for the entire sample, boys, girls, and white students. While BIPOC students reported an increase in their ability to do science, they showed a slight decrease in their feeling of being a scientist. This decrease was 7% or one student. Of those who did not change their responses, three BIPOC students reported feeling like they were getting closer to feeling like a scientist. Students reported changes in their responses to challenges in science class. There was a decrease in students giving up when challenged. Also, there was an increase in using self-sufficient strategies like looking at resources or consulting a peer when faced with challenges. A common theme was that communication with peers was part of students' ability to overcome difficulties in science class.

Based on the findings of this study, researchers were able to draw these conclusions:

- Peer communication and collaboration are vital for students to increase their science self-efficacy. Peer collaboration is especially effective as a tool to increase science self-efficacy for girls.
- Peer collaboration helps students make relevant connections in their science knowledge, and students are more likely to see themselves as scientists when they can communicate their knowledge to peers.
- Peer communication leads to an increase in the use of problem-solving strategies in the science classroom and increases student ability to persevere through learning challenges.

- Peer collaboration supports mastery of daily learning targets for students and increases their confidence in using scientific vocabulary.

This study took place during the 2020-2021 school year amid a global pandemic and nationwide social unrest. These circumstances lead to challenges in the research and likely gave rise to confounding variables that cannot be accounted for. Some limitations of this study include:

- Students had to deal with the changing nature of the learning environment. Students were in this intervention process while adapting to hybrid learning scenarios with some learning time at home and some at school, completely online learning done from their homes and returning to in-person learning at the school building with social distancing restrictions. These inconsistencies, along with students entering and leaving quarantine, lowered group work effectiveness and resulted in smaller sample sizes than Changing nature of the learning environment location, made some inconsistencies in group work effectiveness and resulted in smaller sample sizes.
- At both research locations, student activities were limited by COVID protocols. Students were not permitted to do any hands-on activities that involved moving from their seats or sharing supplies at one site. At the other research location, student and teacher procedures for cleaning materials reduced the number of hands-on activities and the use of instruments with small groups.
- People of color were disproportionately affected by the COVID pandemic and social unrest during the 2020-2021 school year. The added stress and home-life instability may

have affected student ability and could have been a confounding variable in this research study.

Based on the findings and conclusions of this study, the researcher recommended the following course of action:

- Students should be given regular opportunities to solve problems and build knowledge in pairs and small groups. These opportunities allow students to develop high-order thinking skills and practice perseverance, increasing self-efficacy in students.
- Communication between peers should be used to support the learning of new content. When students verbally share ideas, they can practice using scientific vocabulary in an authentic environment. As a result, students become more confident in using more complex reasoning and explanations when brainstorming solutions with their peers and demonstrating mastery of learning targets.
- Establishing peer collaborations groups provides students with a more extensive support system to help them when faced with challenges in science. This support system makes students less dependent on teachers as the sole source of knowledge and more in charge of their own learning experiences.
- Students should regularly reflect on their learning by explaining what they have learned and what tools or strategies helped them increase their understanding. This metacognitive thinking allows them to see how skills can be applied to challenges and situations outside the science classroom context. Likewise, it will enable students to see their strengths, allowing them to gain confidence in the ability to succeed.

- Students should be taught specific peer collaboration strategies to increase the effectiveness of their communication when working in groups. When teachers take the time to demonstrate and allow students to practice communication skills such as accountable talk, students feel more comfortable in sharing their ideas because the classroom environment becomes more welcoming. In addition, teaching collaboration strategies allows students to overcome barriers when working with others who may have different schemas than them.
- Teachers should consistently reflect on their self-efficacy to improve their practice and model metacognition for their students. This self-reflection allows teachers to continuously improve their teaching skills to meet the needs of their students better and adapt to the changing world around them.

In addition to the above recommendations, the researchers suggest the following questions and topics to further analyze the effectiveness and methods in increasing science self-efficacy:

- The findings of the vulnerable groups of this intervention differed in effectiveness. It would be critical to analyze further why science self-efficacy increased significantly for female students and BIPOC students but did self-efficacy not increase significantly for female BIPOC students? While the researchers suggested that it could be due to limited sample size, a more in-depth analysis of students within this group would be recommended to determine if more time or a better strategy would increase the students' confidence in their abilities.

- The protocols placed in the teacher's buildings due to the 2020-2021 COVID pandemic limited the amount of hands-on and physical learning materials that students could interact with during group work. As a result, many students commented in their exit tickets and video journal responses that they didn't feel like scientists because they did not have these experiences while working with their peers. Therefore, researchers would suggest looking into how the inclusion of more hands-on and project-based learning activities affects students' collaboration efforts. Would the inclusion of these additional activities show more growth in science self-efficacy?

Research should continue into the topic of peer-to-peer collaboration in the middle school science setting to address the challenges and questions raised by this study. That being said, the researchers are confident that the type of peer collaboration promoted in the intervention of this study benefits middle school science students by leading to an increase in their science self-efficacy.

References

Alt, D. (2015). Assessing the contribution of a constructivist learning environment to academic self-efficacy in higher education. *Learning Environments Research, 18*(1), 47-67. doi:http://dx.doi.org.pearl.stkate.edu/10.1007/s10984-015-9174-5

Barton, A. C., Kang, H., Tan, E., O'Neill, T. B., Bautista-Guerra, J., & Brecklin, C. (2013). Crafting a future in science: Tracing middle school girls' identity over time. *American Educational Research Journal, 50*(1), 37-75. https://doi-org.pearl.stkate.edu/10.3102%2F0002831212458142

Bolshakova, V. L., J., Johnson, C. C., & Czerniak, C. M. (2011). "It depends on what science teacher you got": Urban science self-efficacy from teacher and student voices. *Cultural Studies of Science Education, 6*(4), 961-997. doi:http://dx.doi.org.pearl.stkate.edu/10.1007/s11422-011-9346-2

Brown, P. L., Concannon, J. P., Marx, D., Donaldson, C. W., & Black, A. (2016). An examination of middle school students' STEM self-efficacy with relation to interest and perceptions of STEM. *Journal of STEM Education: Innovations and Research, 17*(3), 27-38. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/1833036997?accountid=26879

Cheung, D. (2015). The combined effects of classroom teaching and learning strategy use on students' chemistry self-efficacy. *Research in Science Education*, *45*(1), 101–116.

Chung, N., & Ro, G. (2004). The effect of problem-solving instruction on children's creativity and self-efficacy in the teaching of the practical arts subject. *Journal of Technology*

Studies, *30*(2), 116–122.

Colognesi, S., Hanin, V., Still, A., & Van Nieuwenhoven, C. (2019). The impact of metacognitive mediation on 12-year-old students' self-efficacy beliefs for performing complex tasks. International Electronic Journal of Elementary Education, 12(2), 127-136. doi:http://dx.doi.org.pearl.stkate.edu/10.26822/iejee.2019257657

Diverse Role Models. (n.d.). Retrieved October 17, 2020, from http://genderequitableteachingstrategies.weebly.com/diverse-role-models.html

Evans, C. (2020). The impact of integrated STEM equipment on student learning and efficacy in the fourth-grade science classroom. (Action research project, St. Catherine University). Retrieved from https://sophia.stkate.edu/cgi/viewcontent.cgi?article=1377&context=maed

Falco, L. (2019). An intervention to support mathematics self-efficacy in middle school. Middle School Journal, 50(2), 28-44. doi: 10.1080/00940771.2019.1576580

Hsieh, P., Cho, Y., Liu, M., & Schallert, D. L. (2008). Examining the interplay between middle school students' achievement goals and self-efficacy in a technology-enhanced learning environment. *American Secondary Education, 36*(3), 33-50. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/195191923?accountid=26879

Kapucu, S. (2017). Predicting physics achievement: attitude towards physics, self-efficacy of learning physics, and mathematics achievement. *Asia-Pacific Forum on Science Learning and Teaching*, *18*(1).

Leaper, C., Farkas, T., & Brown, C. S. (2012). Adolescent girls' experiences and gender-related beliefs in relation to their motivation in Math/Science and English. *Journal of Youth and Adolescence, 41*(3), 268-82. doi:http://dx.doi.org.pearl.stkate.edu/10.1007/s10964-011-9693-z

Liu, M., Peggy (Pei-Hsuan) Hsieh, Cho, Y., & Schallert, D. L. (2006). Middle school students' self-efficacy, attitudes, and achievement in a computer-enhanced problem-based learning environment. *Journal of Interactive Learning Research, 17*(3), 225-242. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/211316417?accountid=26879

Lodewyk, K. R., & Winne, P. H. (2005). Relations among the structure of learning tasks, achievement, and changes in self-efficacy in secondary students. *Journal of Educational Psychology, 97*(1), 3-12. doi:http://dx.doi.org.pearl.stkate.edu/10.1037/0022-0663.97.1.3

Lofgran, B. B., Smith, L. K., & Whiting, E. F. (2015). Science self-efficacy and school transitions: Elementary school to middle school, middle school to high school. *School Science and Mathematics, 115*(7), 366. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/1729123684?accountid=26879

Marra, R. M., Rodgers, K. A., Shen, D., & Bogue, B. (2009). Women engineering students and self-efficacy: A multi-year, multi-institution study of women engineering student self-efficacy. *Journal of Engineering Education, 98*(1), 27-38. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/217966834?accountid=26879

Morrell, C. and Parker, C. (2013). Adjusting micromessages to improve equity in STEM.

Diversity & Democracy. Vol 16. No. 2.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66*(4), 543-578. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/214115079?accountid=26879

Ramdass, D., & Zimmerman, B. J. (2008). Effects of self-correction strategy training on middle school students' self-efficacy, self-evaluation, and mathematics division learning: The journal of secondary gifted education. *Journal of Advanced Academics, 20*(1), 18-41,196-197. Retrieved from https://pearl.stkate.edu/login?url=https://www-proquest-com.pearl.stkate.edu/docview/222733719?accountid=26879

Schunk, D. (2012). *Learning theories: An educational perspective*. Pearson.

Semilarski, H., Soobard, R., & Rannikmäe, M. (2019). Modeling students' perceived self-efficacy and importance toward core ideas and work and life skills in science education. *Science Education International*, *30*(4), 261–273.

Troop, M., Wallar, L., & Aspenlieder, E. (2015). Developing graduate students' self-efficacy with learner-centered lecturing. *Canadian Journal of Higher Education*, *45*(3), 15–33.

Appendix A

Pre/Post Science Self Efficacy

Adapted from:

Lin, T., & Tsai, C. (2013). A multi-dimensional instrument for evaluating Taiwanese high school students' science learning self-efficacy in relation to their approaches to learning science. International Journal of Science and Mathematics Education, 11(6), 1275-1301. doi:10.1007/s10763-012-9376-6

* Required

1. Email address *

Purpose of the Questionnaire

Please indicate the degree to which you agree or disagree with each statement below by checking the appropriate number to the right of each statement. This questionnaire asks you to describe HOW OFTEN you do each of the following practices when you learn science. There are no right or wrong answers. This is not a test and your answers will not affect your grades in science. Your opinion is what is wanted. Your answers will enable us to improve future science classes.

Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1)

Conceptual Understanding

2. For each statement, choose how often you do each of the following practices, using the scale of: Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1) *

Mark only one oval per row.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
I can explain scientific laws and theories to others	⬭	⬭	⬭	⬭	⬭	⬭
I can use mathematics to solve a science problem	⬭	⬭	⬭	⬭	⬭	⬭
I can make connections between different areas of science (for example: biology and physics)	⬭	⬭	⬭	⬭	⬭	⬭
I know the definitions of basic scientific concepts very well (for example: gravity, photosynthesis)	⬭	⬭	⬭	⬭	⬭	⬭

High-Order Cognitive Skill

3. For each statement, choose how often you do each of the following practices, using the scale of: Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1) *

Mark only one oval per row.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
I am able to explain the solutions of scientific problems.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to design scientific experiments to verify my hypotheses.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to propose multiple solutions to solve a science problem.	⬭	⬭	⬭	⬭	⬭	⬭
When I come across a science problem, I will actively think over it first and develop a plan to solve it.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to make observations and inquires based on a specific science concept or skill.	⬭	⬭	⬭	⬭	⬭	⬭
When I am exploring a scientific idea, I am able to observe how it changes and think of possible reasons behind it.	⬭	⬭	⬭	⬭	⬭	⬭

Practical Work

4. For each statement, choose how often you do each of the following practices, using the scale of: Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1) *

Mark only one oval per row.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
I know how to carry out experimental procedures in the science lab.	⬭	⬭	⬭	⬭	⬭	⬭
I know how to use equipment (for example: measuring graduated cylinders or scales).	⬭	⬭	⬭	⬭	⬭	⬭
I know how to set up equipment for lab experiments.	⬭	⬭	⬭	⬭	⬭	⬭
I know how to collect data during the science lab.	⬭	⬭	⬭	⬭	⬭	⬭

Everyday Application

5. For each statement, choose how often you do each of the following practices, using the scale of: Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1) *

Mark only one oval per row.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
I am able to explain everyday life using scientific ideas.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to propose solutions to everyday problems using science.	⬭	⬭	⬭	⬭	⬭	⬭
I can understand the news/documentaries I watch on television related to science.	⬭	⬭	⬭	⬭	⬭	⬭
I can recognize the careers related to science.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to apply what I have learned about science in school to daily life.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to use scientific methods to solve problems in everyday life.	⬭	⬭	⬭	⬭	⬭	⬭
I can understand and explain social issues related to science in a scientific manner (for example: nuclear power usage and genetically modified food)	⬭	⬭	⬭	⬭	⬭	⬭
I am aware that are	⬭	⬭	⬭	⬭	⬭	⬭

variety of events in daily life involved science-related concepts.

Science Communication

6. For each statement, choose how often you do each of the following practices, using the scale of: Strongly Agree (6), Agree (5), Somewhat agree (4), Somewhat Disagree (3), Disagree (2), and Strongly Disagree (1) *

Mark only one oval per row.

	Strongly Disagree (1)	Disagree (2)	Somewhat Disagree (3)	Somewhat Agree (4)	Agree (5)	Strongly Agree (6)
I am able to comment on presentations and work made by my classmates in science class.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to use what I have learned in science class to discuss with others.	⬭	⬭	⬭	⬭	⬭	⬭
I am able to clearly explain what I have learned to others.	⬭	⬭	⬭	⬭	⬭	⬭
I feel comfortable in discussing science content with my classmates.	⬭	⬭	⬭	⬭	⬭	⬭
In science classes, I can clearly express my own opinions.	⬭	⬭	⬭	⬭	⬭	⬭
In science classes, I can express my ideas properly.	⬭	⬭	⬭	⬭	⬭	⬭

Appendix B

Flipgrid Erin Kaus

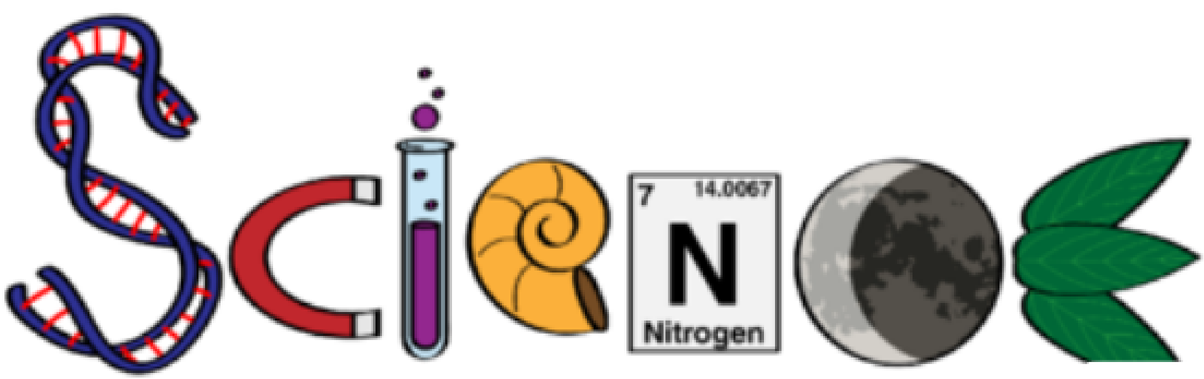
October 25, 2020

Video Journal Responses

Answer the following questions thoughtfully and completely in a Flipgrid video. These questions will help us understand how your feelings about science change over the intervention.

1. What does doing or knowing science mean to you?
2. When doing science, do you feel like a scientist? Why or why not?
3. Do you feel capable of doing science? Why?
4. When you face a challenge or difficulty in science, how do you act?
5. What helps you do science?
6. Do you think there are differences between boys and girls when doing science?

Record a Response



View

Appendix C

Exit Ticket: Student Self Report

* Required

1. Email address *

____

2. What is today's date? *

____

Example: January 7, 2019

3. What hour do you have science? *

Mark only one oval.

- ⬭ 1
- ⬭ 2
- ⬭ 3
- ⬭ 4
- ⬭ 5
- ⬭ 6
- ⬭ 7
- ⬭ 8

4. In 1-2 sentences, explain what the main idea(s) of today's lesson was. In other words, what did you learn? *

5. What part of today's pair work and video meeting did you feel best contributed to your confidence and understanding in scientific processes? *

Appendix D

Gender Equitable Teaching Strategies Performance Based Rubric

In this rubric, all attributes of novice level are evident within the proficient column, all attributes of the proficient column are evident in the exemplary level. Specific manifestations of strategies listed within the rubric are not inclusive of every manner in which that level of performance could be documented, but rather meant as examples.

Strategy	Exemplary	Proficient	Novice
Role Model	Offers numerous opportunities for diverse role models to be present in the curriculum. Develops relationships with community agencies related to the discipline so students can visit on site and have meaningful relationships with role models in various roles. Celebrates women of varied backgrounds and time periods visibly within the classroom, community, and with special events e.g. Women in STEM/CTE days.	Review of curriculum materials demonstrates a balanced portrayal of women and men in slideshows, lesson plan notes, student materials. Invites a female STEM role model to participate in her class at least once during the year using the trained role models. Shares role model videos on a regular basis to ensure students have seen someone who looks/sounds like them succeeding in diverse fields of their discipline.	Recognizes the value of including role models in curriculum materials. Intentionally chooses a diverse array of women to include in visuals; to highlight in curriculum stories. Knows that young women who haven't seen an example of women succeeding in a STEM or CTE field will be much less likely to be able to see herself in that field.
Student Focused Instruction	Using a structured practice that is facilitated through smart technology integration, students consistently spend the bulk of their learning time working in peer groups or with outside mentors to develop their competencies in	Uses self-study and peer-review to analyze the percentage of time spent using lecture, direct instruction, individual assignments relative to those that afford small group interactions among peer groups.	Aware of the efficacy of using diverse forms of lesson activities and interactions to facilitate student learning. Actively chooses to facilitate student interaction within the

Culturally Responsive Practices Self-Assessment Rubric Developed by Alicia Santiago with input from Siri Anderson, Barb Billington, Brenda Britsch, Hilarie Davis, Rita Karl as part of NSF NSF Grant #1513060 a collaborative endeavor of the National Science Foundation, Twin Cities Public Television, St. Catherine University and the University of MN STEM Center.

	course standards and skills. Student voice is incorporated into the design of the course, as well as into a formative feedback mechanism so that the instructor can be actively responsive to ideas that students generate that facilitate improve lesson direction, activities, and outcomes.	Uses accountable talk, SIOP, or (other strategies Barb teaches here) to facilitate students' success in peer groups. For young women and students of color or otherwise marginalized, the teacher has a process in place that specifically aligns dialogue, assignments, or lesson content with goals that are relevant for these populations.	classroom on a consistent basis each week. Comfortable managing students working in small groups for some of the learning time.
Thoughtful, Respectful Communication and Promoting a Growth Mindset	Blind student feedback on course/instructor qualities shows that all students--regardless of background or gender--find the instructor to be encouraging and supportive of their developing competencies in the discipline. In recorded small group dialogues, it is easy to hear that the students know how to: talk to one another in academically meaningful ways; ask and answer furthering questions of one another; treat one another with respect and demonstrate epistemological curiosity; use dialogue to facilitate their shared growth in the discipline. Instructor has a positive attitude towards the potential of all students to succeed with the right learning environment and	Instructor uses blind review of formative and summative assessments to self-assess on the ways in which he provides feedback to learners to further their understanding--and then analyzes the findings for disparities in tone or content that align with the students gender, race, sexuality, language background, etc. Having identified an area that was previously subject to a fixed mindset in her practice, the instructor redesigned the assignment to afford all learners ample opportunities to receive formative feedback from the instructor on learning and improve outcomes with further effort. Instructor tone is respectful and demeanor is encouraging of high standards for all students.	Instructor can articulate the difference between a growth and fixed mindset within her discipline, and provide examples of where previously she has/hasn't facilitated a growth mindset. Instructor begins using a strategy to make feedback to learners less gender-biased (such as asking furthering questions equally often to male and female students, provides similar amount of wait-time to students regardless of background etc.)

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	curriculum. When a student isn't succeeding, the instructor reconsiders how s/he can differently approach the content or pedagogy to afford success.		
Promoting Student Creativity	Classroom feedback from students shows students find the class playful and encouraging of their creativity. Instead of there being assignments with lots of "one right answer," the instructor can point to many assignments where the goals align with creative problem solving, affordances for mixed methods of coming to solutions, and encouragement for authentic learning. In discussions, rather than being corrected, students are encouraged individually and in small groups to work through their initial ideas on a topic, use resources to find answers independently, and bring ideas that are genuinely their own and new (but informed) into the conversation.	Review of curriculum materials demonstrates frequent opportunities for student choice in presenting data/understanding of STEM/CTE concepts. Artifacts created by students are shared revealing a rich array of creative demonstrations of student knowledge and understanding. Periodically (e.g. twice a month) students have an opportunity to complete open-ended assignments that afford them an opportunity to apply an array of problem-solving methods and transfer of learning to new situations.	Recognizes the value of promoting students' creativity in STEM/CTE. Allows for flexible student choice in presenting STEM/CTE content during the semester. Knows that creativity is a cornerstone to success in STEM/CTE careers.
Critical Thinking	Creates a challenging learning environment that exemplifies critical thinking capacities of students discussing STEM/CTE	Review of curriculum materials demonstrates daily opportunities for (and modeling of) students' engagement in critical thinking about STEM/CTE	Recognizes the value of engaging students in critical thinking strategies, with regard to student achievement and learning.

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	concepts; using both examples from hands-on minds-on activities and the STEM/CTE concepts, practices and phenomenon. Collects student feedback on their conceptions of using critical thinking strategies, and incorporates this student feedback into improved implementation of strategies at least once for each unit taught.	content; such as C-E-R and P-O-E. Invites students to share their STEM/CTE conceptions in small and large group settings. Collects student feedback on their conceptions of using critical thinking strategies, and incorporates this student feedback into improved implementation of strategies.	Awareness that activities and practices that promote critical thinking, such as C-E-R (Claims-Evidence-Reasoning) or P-O-E (Predict-Observe-Explain) increase students' critical thinking capacities.
Cultural Awareness and Relevant Learning Experiences	Students' experiences are consistently connected to their culture via activities and community-based experiences. Students autobiographical information is actively incorporated into the course in public and interpersonal details. With active connections between STEM/CTE content and personal interest/experiences. Implements numerous strategies that engage their diverse learners/advisees to see the relevance in their STEM/CTE content.	Teaching strategies as well as learning activities are informed by knowledge of students' interests and skills *as well as cultural backgrounds, and language proficiency*. Review of curriculum materials and visuals demonstrate examples of cultural awareness of the students in their classroom/school in each unit. Invites students to share their experiences related to the STEM/CTE content they are learning, to provide opportunities for student voice to be included in sharing their stories and experiences, increasing engagement and relevancy, through autobiographical video production. Shares examples of professionals in STEM/CTE that represent the diverse student body in their classroom/school.	Teaching strategies as well as learning activities are informed by knowledge of students' interests and skills. Recognizes the value of cultural awareness and making learning experiences relevant to students' lives. Intentionally chooses culturally relevant practices and curriculum materials to engage learners. Knows that girls benefit from increased cultural relevancy in all STEM and CTE experiences.

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Racially and Culturally Responsive Rubric

1- Professional Responsibilities

Goal	Novice	Proficient	Exemplary
Uses self-reflection and awareness to effectively engage students and improve instruction	• Engage in self-reflection to examine his/her own cultural and racial identity. • Limit exploration of personal values, beliefs, strengths, and challenges in relation to culture (gender, race, economic status). • Rarely reflect on values, beliefs, strengths and challenges before making decisions or taking actions. • Become aware of implicit biases that perpetuate inequities (for women and ethically and culturally diverse students). • Rarely seek feedback from others to enhance teaching practices.	• Actively explores personal values, beliefs, strengths, and challenges in relation to culture (gender, race, economic status). • Develops and uses strategies to counteract biases. • Get a better understanding and appreciation for the cultural, ethnic, and racial diversity that exists within his/her community. • Develop a sense of his/her own cultural identity through self-reflection and reciprocal learning • Identify areas of strength, and areas of growth. • Occasionally seek feedback from others but does not or inconsistently incorporates feedback into teaching practices.	• Regularly and consistently explores personal values, beliefs, strengths, and challenges in relation to culture (gender, race, economic status). • Develop knowledge, skills, and a mindset to effectively engage and communicate with diverse students (e.g. teachers' positive belief that he/she is capable of successfully teaching ALL students. Their beliefs turn into actions for positive student achievement). • Regularly seek feedback from others and consistently incorporates feedback into teaching practices. • Model effective practices for other teachers and counselors.

2- Classroom environment and social interactions

Goal	Novice	Proficient	Exemplary
Creates a safe learning environment	• Arrange space for easy movement throughout the classroom. • Manage interpersonal conflict and disruptive behavior. • Check in with students about their concerns to promote positive relations.	• Provide an environment that is respectful, safe from physical harm, unfair treatment, and welcoming to students of all ethnic and cultural backgrounds (students feel safe asking questions and contributing to discussions). • Intentional in creating meaningful connections with youth.	• Creates a safe learning environment where students take academic risks and play an active role (individually and collectively) in preventing behaviors that interfere with learning. • Identify the pressing safety concerns of students. • Students take the responsibility to create positive relationships that contribute to learning. • Establish an environment in which students respect and affirm their own and others' differences and are supported to share and explore differences and similarities related to their cultural background and identity.
Establishes supportive relationships	• Encourages interpersonal relationships based on trust, care, and support. • Develop respectful relationships with students based on trust (Respect enables teachers to reach students' learning styles. Learn about students' struggles and share yours to develop connectedness).	• Develop knowledge about students' cultural backgrounds (and seek to understand) to make connections to their learning (e.g. through shared stories, listening).	• Teachers and students build strong and supportive relationships through mutual understanding and cooperation (allows students to learn and practice prosocial skills). • Teachers show genuine care for students' wellbeing and learning

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Goal	Novice	Proficient	Exemplary
Establishes and maintains classroom routines, procedures, and positive social norms and behavior	• Provides written expectations and discussions about positive social norms around cultural differences, diversity, and integration. • Communicates expectations for classroom routines and procedures. • Promote the development of students' positive personal and social skills. • Implements management strategies that promote helpful behavior, responsibility, and motivation. • Teacher provides constructive, respectful, and timely behavior feedback.	• Develop and cultivate norms that integrate students' voice. • Establish prosocial norms and behavior acceptable to all and do not privilege a particular group (clear expectations, discussions, modeling). • Uses strategies to select and manage instructional groups that reflect diversity. • Promote the development of students' positive personal and social skills.	• Cultivate student's own way of doing things through rules established by the activity and values, habits and expectations upheld by the students. • Students assume responsibility for classroom routines and procedures. • Students assume responsibility for monitoring their behavior and that of their peers.
Communicates high cognitive expectations for learning and performance	• Show genuine respect for students and belief in their capability. • Have similar expectations for youth of all ethnic and cultural backgrounds. • Communicate clear and specific expectations to students about what they are expected to know and be able to do.	• Seek input from students to understand variability in their expectations, habits and ways of doing things. • Create tasks that are cognitively demanding and challenging for all students. • Classroom interactions and instructional outcomes convey high expectations for all students (e.g. everyone can learn STEM, questions are important, mistakes are valuable, STEM is about creativity and making sense, STEM is about connections and communicating, STEM is all about learning (effort), not performing, STEM).	• Consistently enforce expectations for student effort, behavior, and work with special recognition as needed. • Consistently and clearly models how students can master challenging material and meet learning goals through effective effort. • Students engage in challenging work (independently and collaboratively), construct their own knowledge and demonstrate enthusiasm and effort in completing work.

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Goal	Novice	Proficient	Exemplary
Creates a culture of perseverance and hard work	• Encourage perseverance by providing support related to defining tasks, planning, monitoring, changing course of action, dealing with challenges and setbacks (e.g. immediate and informative feedback). • Promote a growth mindset.	• Students use strategies (e.g. problem solving, collaborative group work, seeking assistance from teachers and knowledgeable peers,) to persevere through challenges. • Students see failure as a positive learning experience	• Students value struggle, failure and perseverance. • Students work diligently and show strong perseverance when work is difficult. • Students understand the value of hard work, hone their problem-solving skills and take responsibility for their own academic progress.

3- Preparation of lessons and classroom instruction

Goal	Novice	Proficient	Exemplary
Design culturally relevant lessons and teaching strategies	• Curriculum reflects and values diversity (reflects various values and perspectives). • Lessons incorporate different learning styles (visual, auditory, kinesthetic). • Lessons allow students a degree of choice on topic and/or product presentation.	• Learning activities and instructional strategies are informed by knowledge of students' skills and interests, cultural background and idiosyncrasies. • Lessons display real life, global and culturally diverse and relevant situations. • Integrate differentiated instructional approaches and resources into the curriculum to meet the needs of all students.	• Curriculum is integrated, interdisciplinary, meaningful, and student-centered (includes issues/topics related to students' background and culture, includes information that reflects students' perspectives, includes culturally-relevant information students can identify with). • Curriculum provides students with options that are challenging, and incorporate inquiry and higher order thinking skills that personalize connections and evoke multiple perspectives.

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Goal	Novice	Proficient	Exemplary
Uses instructional strategies that engage all students in learning	• Teacher facilitates and guides classroom learning. • Use interactive and problem, project, and goal-based instruction to engage students. • Use flexible, equitable, and heterogeneous groups to help each student contribute to all tasks. • Implement technology-enriched instruction to facilitate student learning through active engagement. • Occasionally reflect on the effectiveness of lessons and interactions with students (individually and with colleagues).	• Implement activities that are problem-oriented, have real-world applicability, require higher-order thinking skills, collaboration with others, involve integrated instruction and are project-based. • Foster students' sense of belonging by actively seeking students' input on activity/project goals, and design activities around students' community concerns. • Students assume the role of an explorer. • Implement peer-based instructional strategies that foster interpersonal skills. • Implement instructional conversations to develop students' language and thinking skills and to guide the learning process. • Assessment is performance-based (not traditional/tests) and tailored to individual needs and goals (e.g. authentic assessment –evaluates students' ability in real-world context; alternative assessment –measures students learning in forms other than pencil/paper tests), and integrated performance assessment – includes interpretive, interpersonal, modes of communication). • Regularly reflect on the effectiveness of lessons and interactions with students (individually and with colleagues).	• Regularly provide opportunities for students to contribute their knowledge and perspectives about a lesson's topic(s) and use the knowledge to plan and sequence the lesson (e.g. ask open-ended questions to discover what students already know, present and connect new skills and information to students' responses). • Promote family and community involvement to allow the implementation of effective, culturally responsive activities that can connect with youth in a meaningful way. • Provide culturally responsive feedback (CRF) that is critical, ongoing and immediate (CRF- incorporates students' responses, ideas, languages, experiences in a manner sensitive to students' individual and cultural preferences). • Use cognitively guided instruction - involves explicit discussion of instructional expectations. Requires teachers to exemplify learning outcomes of CRT, which include strategy use, content learning, metacognitive and critical thinking, and interest and respect for cultural and linguistic diversity. • Students appear to have a great deal of control over the learning that occurs in the classroom (e.g. students' comments and questions often determine the focus and direction of instruction/learning; there is a high proportion of student talk (between and among them) related to content, and students have a desire to explore and inquire). • Students model performance expectations for each other in a variety of ways, but all demonstrating mastery. • Regularly reflect on the effectiveness of lessons and interactions with students – individually and with colleagues – and uses and shares with colleagues, insights gained to improve practice and student engagement and learning.

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Appendix E

Peer to Peer Collaboration Models and The Effect of Self Efficacy
Parental Permission Form

1/27/2021

Dear Parents and/or Guardians,

In addition to being your child's 8th-grade science teacher, I am a St. Catherine University student pursuing a Masters of Education. As a capstone to my program, I need to complete an Action Research project. I am going to study how working with peers affects a student's confidence in their scientific abilities. Previous research has found that increasing this confidence, also called science self-efficacy, has proven to increase academic achievement in the science classroom for all students.

In the coming weeks, I will be partnering each student with a student in the other color group or with other distance only learners (i.e. gold student with maroon student), and students will work with each other through google meet video meetings to learn the scientific concepts and share ideas with each other as a regular part of science lessons and daily activities. These activities could include things such as having a student in school describing and modeling a lab that is being done in the classroom, while the student learning from home adds the data to a shared lab report, or a student at home going outside to measure the wind speed and direction while the student in school writes down the observations and data into a shared activity guide. After these activities, students will fill out an exit slip describing how confident they feel about the material they learned and what parts of the group work best helped them understand. All students will participate as members of the class. In order to understand the outcomes, I plan to analyze the data obtained from the results of these exit slips in addition to asking students about their current confidence levels in science through a google form and recording a video of themselves on flipgrid discussing their science self-efficacy. We will do this at the beginning and end of the research project to determine if working in collaboration with other students is making individual students feel more confident about their scientific abilities and knowledge. In addition, I will also be reflecting on how my teaching strategies through the project promote an improved classroom environment where students feel comfortable discussing and working with others to reach scientific solutions. All strategies implemented and assessments given are part of normal educational practice.

The purpose of this letter is to notify you of this research and to allow you the opportunity to exclude your child's data from my study.

> **If you decide you want your child's data to be in my study,** you don't need to do anything at this point.
>
> **If you decide you do NOT want your child's data included in my study,** please note that on this form below and return it by February 26, 2021. Note that your child will still participate in the peer group work but his/her data will not be included in my analysis.

In order to help you make an informed decision, please note the following:

- I am working with a faculty member at St. Kate's and an advisor to complete this particular project.
- Some benefits of this student include increased confidence in being able to do and understand science, better communication and collaboration skills, increased interest in joining the scientific community as a career, increased understanding of how the world works around us, higher self-esteem, and perseverance in the face of struggles, and an increase in community members who are critical thinkers who take action on issues within the community. Some risks are having more dependence on the support of peers to complete tasks, internet issues that may have students struggling to connect, and learning may take longer.
- I will be writing about the results that I get from this research. However, none of the writing that I do will include the name of this school, the names of any students, or any references that would make it possible to identify outcomes connected to a particular student. Other people will not know if your child is in my study.
- The final report of my study will be electronically available online at the St. Catherine University library. The goal of sharing my research study is to help other teachers who are also trying to improve their teaching.
- There is no penalty for not having your child's data involved in the study, I will simply delete his or her responses from my data set.

If you have any questions, please feel free to contact me at ekaus@flaschools.org. You may ask questions now, or if you have any questions later, you can ask me, or my advisor Dr. Megan Olivia Hall (meganoliviahall@gmail.com), who will be happy to answer them. If you have questions or concerns regarding the study and would like to talk to someone other than the researcher(s), you may also contact Dr. John Schmitt, Chair of the St. Catherine University Institutional Review Board, at (651) 690-7739.

You may keep a copy of this form for your records.

Erin Wilmes (Kaus)

1/27/2021
Date

OPT-OUT: Parents/Guardians, in order to exclude your child's data from the study, please sign and return by February 26, 2021. You may also respond via email with this same information below.

I do NOT want my child's data to be included in this study.

Signature of Parent/Guardian ______________________

Date ______________

Appendix F

Focus Group's Quotes from Initial and Final Video Journal Responses

Student #	Initial Responses	Final Responses
21	" I don't feel like a scientist because I don't like to do experiments and activities." " I don't really feel capable because science is hard to do and understand."	"I still don't feel like a scientist because I don't have interest in it" **"I feel more capable, but there is still part of me that still struggles. I hope to continue to improve."**
38	"When I do science, I don't really feel like a scientist because I just feel like it's another class that I have to do." "Sometimes I feel like I can do science if I understand it. If I don't understand it, then I don't know what to do."	"I wouldn't say I feel like a scientist, but **I do feel like I have more knowledge in science than I did earlier this year. I can engage more and actually understand the concepts. Just being able to understand the concepts gives me a lot more confidence and makes me want to talk about the topics more with other people and lets me engage better in the classes activities."** **"I do feel a lot more capable now because I've started to pay a lot more attention in class. Just being able to talk with other people and having them there for support is an option I like having."**
39	"I guess sometimes I feel like a scientist when we're doing labs and stuff." "Yeah. I don't know if I feel capable. I like math because there's always an answer to every problem, and I think the science that we do is like that, but I don't think I like experimental science."	"I don't feel like a scientist, but **now I enjoy understanding things that are around me."** **"I feel more capable because science showed me I can always find the answers even if it takes a long time."**
87	"When doing science, I don't necessarily feel like a scientist, but when doing scientific experiments, I do feel more like a scientist. I guess this is	**"When doing science, I do feel a little more like a scientist because I feel like my skills in science have gotten better over the year, and I'm able to**

	because I mentally envision an associated scientist with someone in a chemistry lab with a white lab coat." I feel capable of doing science because these things come fairly easy to me. Why? I'm engaged by the ability to learn and obtain information and be able to recall the information.	**understand more concepts and things."** I do feel capable because I can wrap my head around the concepts easily, and there are some things that you have to think about more, but **I do feel like I'm able to understand it in context more.**
109	"Personally, no, I do not feel like a scientist when I'm doing science because I know that I still have a lot of things I need to learn and do in order to feel and be a real scientist. " "Yes, I do think I am at least capable of doing science. I think this because I know that I, well, I'm not the best at doing science. I can improve along the way and get better in order to be able to do science."	"I don't feel like a scientist yet, because I know that I still need a lot to learn since I don't even know the fundamentals of being a scientist yet. However, **I consider myself to be like a science apprentice because I'm trying to be hard is to learn."** **"**I feel like **I'm capable enough to do things like work that is part of my grade level,** but I don't feel like I'm like that high up and experienced enough to be the best in doing it."
140	"When I'm doing science, I don't feel like a scientist unless I'm doing experiments because I'm just learning." "I don't feel capable of doing science because there's a lot of stuff you have to remember, and I tend to forget things easily."	"When I'm doing science, I don't really feel like a scientist because this year we haven't really done any experiments or used the lab. I feel like a scientist when I am doing experiments." "**I do feel capable of doing science**, but sometimes the scientific vocabulary can be confusing or it can be difficult to memorize. **Having visual examples and the teacher or peers explaining helps me**. "

Note. Bold represents positive changes in responses.