MINDFULNESS-BASED SOCIAL EMOTIONAL LEARNING IN THE SCIENCE CLASSROOM

by

Caleb Denver Cochrum

A professional paper submitted in partial fulfillment
of the requirements for the degree

of

Master of Science

in

Science Education

MONTANA STATE UNIVERSITY
Bozeman, Montana

July 2021

STATEMENT OF PERMISSION TO USE

In presenting this professional paper in partial fulfillment of the requirements for a master's degree at Montana State University, I agree that the MSSE Program shall make it available to borrowers under rules of the program.

Caleb Denver Cochrum
April 2021

TABLE OF CONTENTS

1. INTRODUCTION AND BACKGROUND 1

Context of the Study 1
Focus Statement and Questions 2

2. CONCEPTUAL FRAMEWORK 3

Social Emotional Learning 3
SEL Best Practices 4
SEL Outcomes 5
Mindfulness 6
Mindfulness Best Practices 7
Integration of Mindfulness and Social Emotional Learning 8
Why SEL and Mindfulness in the STEM classroom? 8
Assessing the Impact of Mindfulness and SEL Learning 9
Theoretical Underpinning 10

3. METHODOLOGY 10

Demographics 11
Treatment 12
Social Emotional Learning Lessons 12
Mindfulness 12
Reasoning for Treatment 13
Implications of COVID-19 on Classroom Treatment and Student Population 14
Data Collection and Analysis Strategies 15
Student Achievement 16
Class Culture 17
Student Self-Efficacy 18

4. DATA ANALYSIS 19

Results 19
Student Achievement 20
Class Culture 23
Student Self-Efficacy 25

5. CONCLUSION 29

Claims from the Study 29
Mindfulness and SEL Improves Student Achievement 30

TABLE OF CONTENTS CONTINUED

Mindfulness and SEL Improves Class Culture 31
Mindfulness and SEL Improves Student Self-Efficacy 33
Value of the Study and Consideration for Future Research 33
Impact of Action Research on the Author 35

REFERENCES CITED 36

APPENDICES 40

APPENDIX A: IRB Approval Form 41
APPENDIX B: Science Interest Questionnaire 43
APPENDIX C: Self Efficacy Formative Questionnaire 45
APPENDIX D: Example SEL Lesson 47
APPENDIX E: Example Mindfulness Script 49
APPENDIX F: Sample SEL Lesson Case Study 51
APPENDIX G: Forces Test 53

LIST OF TABLES

Table Page

1. Study Demographics 11

2. Data Triangulation Matrix 16

3. Pre- and Post-Test Scores for Unit Assessment 20

LIST OF FIGURES

Figure Page

1. Average Student Semester Grade Data....21

2. District Based Science Assessment Results....22

3. Referral Data per Student....25

4. Student Self Efficacy Survey Results....26

5. Science Interest Questionnaire Pre- and Post-Test Data....27

ABSTRACT

This study evaluated the impact of implementing daily mindfulness and biweekly social emotional learning lessons into a sophomore level Physical Science classroom. Qualitative and quantitative data collected through student surveys, attendance data, content-based assessments, was analyzed to assess the overall impact on student learning, classroom culture, and student self-efficacy. Results indicate that the use of mindfulness and social emotional learning curricula significantly improves classroom culture, while also having a marginally positive impact on academic performance and student self-efficacy.

INTRODUCTION AND BACKGROUND

Context of the Study

James B. Conant High School is a mid-size public high school in Hoffman Estates, Illinois, a suburb about 50 minutes northwest of Chicago. James B. Conant High School serves 2,334 students, grades 9-12. 46% of the student population is Caucasian, 27% is Asian, 17.5% is Hispanic, and 4.3% of the school population is Black.

The economic situation of students at Conant High School is similarly diverse. The school is located near one of the most prosperous shopping areas in the suburbs of Chicago. Consequently, many of the students come from upper-class backgrounds. Additionally, there are multiple government-subsidized housing complexes within the school zone in which many lower-income families live. Compared to the rest of the state, however, a low percentage of the student population is economically disadvantaged. 27.9% of students qualify for free and reduced-price meals at Conant High School. This is compared to 48.8% of students in Illinois qualifying for such benefits.

For this research, data from one section of a general education Physical Science class was analyzed. Physical Science is a remedial level science class that studies both Physics and Chemistry content. This class serves many students who have experienced barriers to their education. In the 2019-2020 school year, 29% of the class population qualified for special education services (compared to 14% school-wide), 25% of the class population struggled with chronic absenteeism (compared to 8% school-wide), and 21% of the class qualified as English Language Learners (compared to 4.1% school-wide).

The diverse needs of the student population in this class necessitate creative solutions and educational supports. Baseline data revealed that the student population enrolled in Physical Science frequently struggled with behavioral issues, low academic achievement, and low engagement. In an effort to meet the needs of these students and encourage greater academic engagement, mindfulness and Social Emotional Learning (SEL) curricula were implemented concurrently on a regular basis.

The teacher of this class has taught for four years and has a bachelor's degree in Physics and Secondary Education. In addition to teaching Physical Science, he teaches Physics classes at the regular and AP levels. The teacher has worked at Conant High School for his entire career.

The following paper will describe the growing body of research involving mindfulness and Social Emotional Learning (SEL) curricula in the classroom and seek to apply it to the aforementioned Physical Science course. Data taken prior to the implementation of both mindfulness and SEL curricula will be compared to post implementation data to discern the impact of mindfulness and SEL curricula on student achievement, student self-efficacy, and classroom culture.

Focus Statement and Questions

The focus of this study is to determine the impact of mindfulness-based SEL curricula on student learning. Sub-questions answered by this research include the following:

1. How does the incorporation of mindfulness-based SEL curricula in the general education science classroom influence student achievement?

2. How does the incorporation of mindfulness-based SEL curricula in the general education science classroom influence class culture?
3. How does the incorporation of mindfulness-based SEL curricula in the general education science classroom influence science self-efficacy?

CONCEPTUAL FRAMEWORK

Students grow and develop academically, socially, and emotionally throughout their time in the educational system. Many lesson plans, however, focus solely on how to support student academic development rather than and sometimes at the expense of their social and emotional development. In recent years, SEL curricula and mindfulness have become popular supports for student social and emotional development. The following section will describe these supports, best practices for their implementation, and research done to determine the efficacy of each.

Social Emotional Learning

Social Emotional Learning (SEL) curricula has been studied as an academic support with significantly positive outcomes. SEL has been defined by the Collaborative for Academic, Social, and Emotional Learning (CASEL) as "the process through which children and adults acquire and effectively apply the knowledge, attitudes, and skills necessary to understand and manage emotions, set and achieve positive goals, feel and show empathy for others, establish and maintain positive relationships, and make responsible decisions" (CASEL, 2015). Continued research points to the effectiveness of SEL curricula in reducing problem behaviors and emotional distress as well as increasing student achievement and positive social behavior.

SEL Best Practices

Successful SEL curriculum involves implementing stand-alone lessons targeted at specific social and emotional skills and infusing classroom practices and curriculum with

social emotional learning (CASEL, 2015). Building on the research done by CASEL, the Indiana Department of Education suggests that effective SEL curriculum is sequenced, active, focused, explicit, and reflective (Oliver, 2018). SEL lessons should naturally flow in a clear sequence of steps. In the research context, lessons regularly built on ideas learned in previous SEL lessons. As with any curriculum, stand-alone SEL lessons should provide students opportunities to practice and apply their learning in new scenarios. These lessons should also be active, with activities that are experiential and hands-on. In the research context studied, it was found that case studies and discussions were effective in helping students apply their learning in new ways. A case study that was utilized in a free-standing SEL lesson is attached in Appendix F. SEL lessons have also been found to be most effective when they are focused and explicit, with specific lessons on narrow topics. Finally, reflection is a key element to any effective SEL curriculum. In the research context, students were often asked to write out how they had used a previous lesson in the past week or day. They wrote out their reflections on a card and turned it in for a small participation grade.

Infusing classroom practices and curriculum with social emotional learning involves creating a positive environment in which students feel safe to take risks and grow. According to the CASEL guide, students need to feel heard by their teachers, have opportunities to exert autonomy, and must be governed by clear and consistent rules to experience the highest benefit of SEL curriculum. In the research context studied, consistent rules were outlined on the first day of class and were maintained throughout the school year. In addition to this, a few minutes of each lesson were specifically allotted

to talking about ideas and events that were outside of the class curriculum and that interested the students in the class. This time provided positive examples of relationship building and developed teacher-student relationships.

SEL Outcomes

SEL curricula have been implemented in educational environments across the country with strikingly positive results. Schools have seen student behavior and achievement improve as these programs gain consistency and frequency. A meta-analysis conducted by CASEL SEL programming revealed significant and positive academic outcomes (Durlak et al., 2011). This research involved 270,034 kindergarten through high school students at 213 schools. The research found that students who received Social-Emotional instruction saw an 11 percentile increase in their achievement when compared to control groups. Very few educational practices produce such positive results.

Follow-up research conducted six years later found that students who received SEL support reported a significant increase in indicators of well-being (Taylor et al., 2017). These indicators included positive academic outcomes, understood to produce a significant increase in average lifetime earnings. The researchers reported a 6% increase in high school graduation rates (average increase in lifetime earnings of $367,687), a 10.5% increase in college attendance (average increase in lifetime earnings of $637,621), and an 11% increase in college graduation with a degree (average increase in earnings of $1,138,054). Students receiving SEL curricula also reported an 38.5% decrease in STD diagnosis, an 18.5% decrease in arrests, and a 1.5% decrease in substance abuse. Taken

as a whole, it is clear that implementing SEL curricula results in a wide range of positive outcomes for students.

Mindfulness

Over the past two decades, significant research has been done on the positive impact of mindfulness on the brain (Keng, Smoski, & Robins, 2011). Mindfulness is a practice specifically designed to focus one's attention on the current moment, calmly becoming aware of the thoughts, sensations, and emotions that one is experiencing. It often involves deep breathing exercises and hyper-focusing on specific stimuli in one's surroundings.

A study completed through the Boston Charter Research Collaborative considered the impact of mindfulness on school performance (Gutierrez et al., 2019). Their study considered both the development of mindful attitudes in students as they progressed through a mindfulness curriculum and the academic performance of students who progressed through this curriculum with respect to the achievement of a control group. As part of the research, students took part in two surveys both before and after the curriculum was implemented. The first was the Mindfulness Attention Awareness Scale (MAAS) which asked students to rank their ability to be in the moment and pay attention to tasks that were in front of them. The second asked students to describe their perceived level of stress, self-control, and mindful attention.

The results of the study concluded that mindfulness was directly correlated to decreased stress hormone creation, prosocial behavior, and increased student attention spans (Gutierrez et al., 2019). These results quantify the significant positive outcomes of

these supports as they have been implemented in both regular education and special education settings.

Mindfulness Best Practices

In the research context considered, consistency and student autonomy were found to be crucial to the success of mindfulness practices. In the research context considered, students were provided with short mindfulness exercises every day. If mindfulness practices are only used in stressful situations (i.e. test days), the practices are then associated with stress. By implementing them every day, the practices provide a calming baseline that is natural to the brain. It was also found that student autonomy was important in these practices. Throughout the year, students were allowed to either close their eyes or put their heads down on their desks throughout the exercises at the beginning of class. They were not forced to participate but were asked to put away any screens and any additional stimuli throughout the duration of the mindfulness exercise. The consistency and autonomy involved with the implementation of mindfulness was found to increase student engagement throughout the year.

Integration of Mindfulness and Social Emotional Learning

Continued research needs to be done on using Mindfulness-Based Practices (MBP) and SEL curricula in conjunction with one another. In a meta-analysis of the positive impact of both MBP and SEL curricula, researchers argue that the two practices naturally fit together as they both aim to improve student emotional awareness and regulation (Gueldner & Feuerborn, 2017). The need for additional research on the impact

of combining these two practices was the impetus for this project. There has been significant research done on MBP implementation and SEL implementation individually and the results have been positive and encouraging. At the same time, there is still research to be done on integrating the two practices into one curriculum. This study will look to evaluate the impact of implementing an integrated curriculum.

Why SEL and Mindfulness in STEM Education?

At first glance, Social-Emotional Learning and Science, Technology, Engineering, and Mathematics (STEM) Education seem to be unrelated. However, many of the skills and practices developed in these two disciplines are very similar. “Both are fundamental to solving open-ended problems and exploring real-world ideas, and improving both STEM skills and social emotional skills requires practice, experimentation, and working with others” (Salmons & Smith, 2018). The following research conducted at Conant High School included SEL lessons that encouraged collaboration, critical thinking, and discussion. These are skills necessary for work in any STEM field. In addition to this, scientific research was presented in almost every SEL lesson as evidence to support the importance of making positive and healthy decisions.

Assessing the Impact of Mindfulness and SEL Lessons

An effective mindfulness and SEL program will result in increased academic achievement, improved attitudes and behaviors, fewer problem behaviors, and reduced emotional distress (CASEL, 2015). While academic achievement is easily measured based on test scores and semester grades, the other criteria for effective programs are

often more difficult to quantify. This research considered attendance data, referral data (specifically the number of times students were referred to an administrator for disciplinary action), and student interviews and surveys to determine how the curriculum impacted their behavior and perceived levels of emotional distress. The survey included in Appendix C is an example of one such survey.

Theoretical Underpinning

The theoretical underpinning behind the use of SEL curricula goes far beyond simply increasing scholastic achievement in areas such as test scores and attention span. SEL curriculum is designed to train students to make positive and educated decisions, both in and out of the classroom setting. It is meant to build student skills that will help them satisfy their present needs and prepare for a positive future. To accomplish this, "the needs of youth must be addressed by creating environments or settings that promote outcomes like school achievement, mutually supportive relationships with adults and peers, problem-solving, and civic engagement" (Bracket & Rivers, n.d.). The authors suggest that SEL curriculum offers a positive approach to addressing these needs by building student assets and skills rather than reducing risk factors.

The authors also suggest that this positive approach to student development is based on the Ecological Systems Theory. This theory posits that student development is shaped by the settings in which the students inhabit. SEL curriculum is designed to create positive learning environments that are necessary for this positive youth development.

METHODOLOGY

The classroom treatment was administered over the first semester of the 2020-2021 school year. One section of Physical Science, composed of 27 students, was considered. The research methodology for this project received an exemption by Montana State University's Institutional Review Board and compliance for working with human subjects was maintained (Appendix A). Students took part in mindfulness activities every class period as well as SEL lessons every two weeks.

Demographics

Of the 27 high school students that participated in the study, 44% (*n*=12) of students identify as Hispanic/Latino, 41% (*n*=11) of students identify as white, 7% (*n*=2) of students identify as Asian/Pacific Islander, 4% (*n*=1) identify as Black or African American, and 4% (*n*=1) identify as Multiracial. Further details on the student population are shown in the table below:

Table 1. Study demographics.

Class Period	# of Students	Males	Females	ELL	SPED
3B	27	15	12	1	11

It is important to note that student attendance has declined in the remote learning environment. As a result, not every student responded to the pre- and post-treatment surveys given at the beginning and end of the semester.

Treatment

Mindfulness

At the beginning of each class period, students were led through a short mindfulness exercise. Deep breathing exercises were the most commonly used technique to begin class. In this technique, the instructor directs students to close their eyes. The instructor then directs students to breathe in and breathe out at slow, regular intervals. An example of a script used in this technique is in Appendix E. Another exercise used regularly was a mindful "body-scan". For this technique, the instructor directs students to close their eyes and focus their attention on specific parts of their body. Students are asked to relax each part of their body as they focus. The third most commonly used mindfulness practice was thoughtful listening. The instructor will strike a bell and students will raise their hands. They will put their hands down when they can no longer hear the bell. Each of these exercises is specifically designed to help the brain relax by taking its attention off stressful stimuli from previous experiences and directing its attention to the present moment.

Social Emotional Learning Lessons

In conjunction with CASEL, the Illinois State Board of Education developed three main Social-Emotional Learning standards for students in public education. The three standards are as follows:

1. Standard 1 - Develop self-awareness and self-management skills to achieve school and life success.

2. Standard 2 - Use social-awareness and interpersonal skills to establish and maintain positive relationships.
3. Standard 3 - Demonstrate decision-making skills and responsible behaviors in personal, school, and community contexts.

Every two weeks, after engaging in a mindfulness activity, students were led through a Social Emotional Learning lesson that connected to one of these three goals. For instance, a lesson regarding stress management was conducted to help students move towards proficiency in standard 1. In an effort to help students grow in their social awareness and interpersonal skills (standard 2), a lesson on conflict resolution was taught. A lesson on problem sizing (reacting to problems with the appropriate amount of emotion and energy) was given to help students develop the skills outlined in standard 3. For each lesson, students took part in a game or activity, discussed a case study, watched a short video, or took a survey. At the end of each lesson, students had time to reflect on the lesson and how it could be applied to their lives outside of the classroom. A sample lesson is included in Appendix D.

Reasoning for Treatment

In the past, student behavior issues and lack of emotional regulation have been significant barriers to student learning, specifically in the Physical Science classroom. In the past, these issues have created negative classroom environments in which students have struggled to learn and feel safe. The mindfulness-based Social Emotional Learning curriculum was implemented with the goal of removing these barriers and ensuring higher quality science education.

Both mindfulness practices and Social Emotional Learning curricula aim to enhance student emotional regulation and awareness and are thought to have an additive effect when used in conjunction (Gueldner & Feuerborn, 2015). Thus, both supports were implemented in an effort to further mitigate barriers to education.

Implications of COVID-19 on Classroom Treatment and Student Population

Significant changes were made to the school schedule and the classroom environment in consideration of student and staff safety during the COVID-19 pandemic. Classes followed a block schedule, meeting every other school day for one hour. For most of the semester, classes were conducted exclusively via online teleconferencing software. For three weeks during the semester, classes were conducted in a hybrid model with half of the student population present in the classroom while the other students joined via the online software.

Administration of MBP and SEL curricula was significantly altered due to these changes. Ideally, daily mindfulness treatment would be administered along with weekly SEL lessons. Due to the altered schedule, MBP supports were administered every other day while SEL lessons were taught biweekly.

The effects of COVID-19 on the student population also impacted the findings of this study. Many students reported additional responsibilities such as taking care of younger siblings or taking on jobs during normal school hours. As a result, student attendance was decreased. Additionally, some students were forced to attend classes from environments not conducive to learning. One student reported attending class from a parent's worksite, another from the car on the way to work, and another from a crowded

hotel room with her family. Other students attended class from their beds and found it difficult to stay awake throughout the lessons. These examples are representative of much of the student population studied in this research.

Data Collection and Analysis Strategies

This research looks to determine how mindfulness based SEL curriculum impacts student achievement, class culture, and science self-efficacy. Data sources for each sub question are shown in Table 2 below.

Table 2. Data Triangulation Matrix.

Focus Questions	Data Source 1	Data Source 2	Data Source 3
1. How does the incorporation of mindfulness-based SEL curricula in the general education classroom influence student achievement?	Data from a unit pre and post test	Data from semester grades as compared to semester grades from previous years	Data from a standardized district assessment
2. How does the incorporation of mindfulness-based SEL curricula in the general education classroom influence class culture?	Student survey data	Referral data	Class attendance data
3. How does the incorporation of mindfulness-based SEL curricula in the general education classroom influence science self-efficacy?	Student interview	Self-Efficacy Formative Questionnaire	Science Interest Questionnaire

Student Achievement

To measure the impact of the curriculum on student achievement, semester grades, results from a unit pre and post-test, and results from a district-based assessment were analyzed. The semester grade will be used for student official transcripts and the mean semester grades for three years of classes were compared and subdivided by IEP and LEP students. These grades depict not only student assessment data but also student performance on formative assignments throughout the semester.

The second measure of student achievement was a district-based science assessment given at the end of the semester. This assessment is a multiple-choice content test that is given every year. Using an independent samples t-test, results from the class that participated in the curriculum were compared to results from students who took the same class in a prior year and did not participate in the same curriculum. This test was given as a final exam in the 2018-2019 and 2019-2020 school years and as a formative assessment in the 2020-2021 school year. It provided data on student understanding and retention of the information presented throughout the semester. Data from this comparison is represented with a bar chart in the results section.

The third measurement of student achievement will be a pre and post-test on the Forces unit (Appendix G). At the beginning of the unit, students were given a multiple-choice test measuring their understanding of forces. At the end of the unit, students were given a mirrored post-test. Results of the post-test were compared to results from the pre-test using a two tailed t-test and are tabulated in the results section.

Class Culture

To measure the impact of the curriculum on class culture, responses to student questionnaires will be used. At the end of the first semester, students filled out a survey about class culture. This survey was a google form and automatically tabulated the data collected. This survey asked students to compare the class culture to other classes that they attend regularly. Results from this survey are represented in a bar graph in the results section.

Referral data was also used as a measure of the curriculum's impact on class culture. Referral data can certainly be skewed by specific students but as a general rule, this data reflects the student-teacher interactions and the student-student interactions that take place in the classroom. The number of referrals, as well as the content of the referrals, was again compared to classes in past years where mindfulness based SEL curricula was not utilized. Student confidentiality was maintained through the duration of the research and only general patterns are reported.

Finally, attendance data from both current and previous years was used to measure the impact of mindfulness-based SEL curriculum on class culture. It is expected that as class culture improves, so does student attendance. This does, however, come with a very specific caveat. Students who struggled with chronic absenteeism were not considered. The main measurement considered was based on students who attend other classes during the school day but may not attend their Physical Science class. This data will be less skewed by outside influences such as student health concerns and other barriers to student attendance.

Student Self-Efficacy

To measure the impact of the curriculum on student self-efficacy, the Self-Efficacy Formative Questionnaire, developed by the Research Collaboration, was given as a pre- and post-assessment preceding and following the first semester of the curriculum. This questionnaire has been widely accepted as a good measure of a student's belief that he or she can perform to a given standard and achieve future goals (Gaumer et al., 2018). In addition to this, a Science Interest Questionnaire was given as a pre- and post-assessment (Appendix B). This survey provides a metric with which one can measure student self-efficacy, specifically in the field of science (Walls, 2012). As the study took place specifically in a science classroom, the connection between mindfulness-based curriculum and student interaction with the subject material was explored. The questionnaires were given as google forms and graphs of the pre- and post-assessments are provided in following sections.

Additionally, select students (n=5) were interviewed at the end of the semester about how the curriculum impacted them outside of our classroom. This interview took place in a zoom breakout room with all five students. Results from this interview were recorded and quotes are included in the results section of this paper.

DATA ANALYSIS

Results

The triangulation matrix displayed in table 2 describes the data collection methods used in this study. These research methods described yielded significant data. For pre- and post-tests, student scores were assigned a unique id number used to track the progress of individuals over time. Scores for students who were unable to take a pre- or post-test are not included in this study.

Student Achievement

The impact of mindfulness based SEL curricula on student achievement was measured first by comparing test scores for a mirrored pre- and post-test given at the beginning and the end of the Forces unit. Only scores from students who took both the pre-test and the post-test (n=19) were considered. The pre and post-tests each consisted of 24 questions. Results of the pre- and post-assessments are tabulated below.

Table 3. Pre- and post-test scores for unit assessment.

	Mean (score out of 24)	Standard Deviation	Mean of Post-test minus Pre-test	Two-tailed P value	N
Pre-test	8.58	3.53	8.21 (95% confidence interval between 10.4 and 6.02)	<0.0001	19
Post-test	16.79	4.18			

Mean scores for the pre and post tests were subject to a two tailed T-test and results are shown in Table 3. The two-tailed P value was calculated to be less than 0.0001. By conventional criteria, this result demonstrates a difference between the two

groups of scores that is extremely statistically significant, and a null hypothesis can be rejected. The normalized gain between the pre and post test scores was found to be g = 0.53. Taken together, it is clear that students experienced a significant increase in understanding throughout the Forces unit.

The second measure of student achievement was student semester grades as compared to previous years. This was selected to provide an overview of how the implementation of mindfulness and SEL curriculum impacted student work completion, work quality, and performance on assessments. Data from the past three years is shown in the graph below.

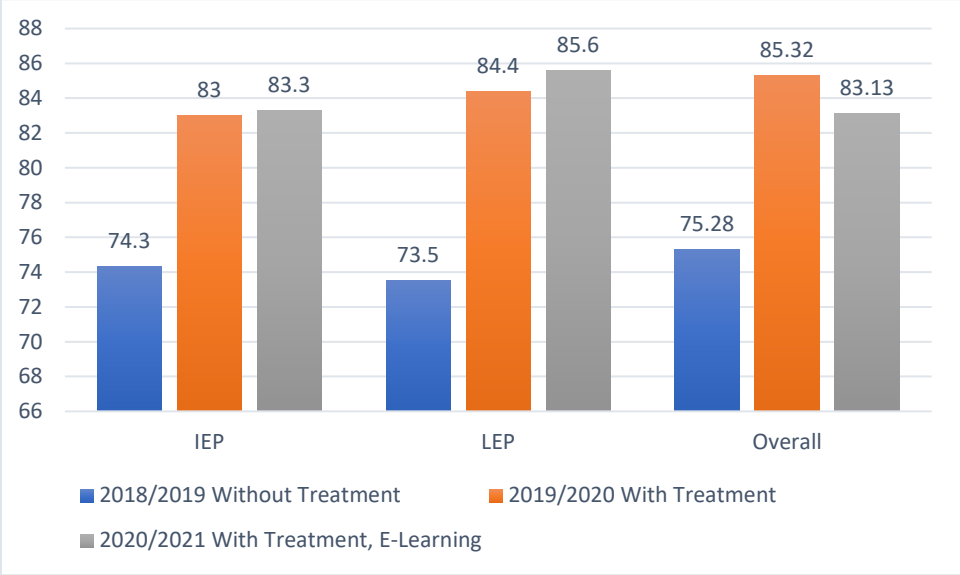


Figure 1. Average student semester grade data.

Three years of semester grade data was considered. Students in the Physical Science course in 2018-2019 were in a traditional classroom setting and did not experience daily mindfulness practices or SEL lessons. Students in the course in 2019-2020 experienced the support in a traditional classroom setting. Students in the course in

2020-2021 experienced the support in a remote and hybrid learning environment. Apart from the mindfulness and SEL supports, classroom activities, assignments, and assessments were closely mirrored from the 2018-2019 school year to the 2019-2020 school year. Assignments, activities, and assessments were modified in the 2020-2021 school year to fit the remote and hybrid learning environment.

The data was broken down to show the impact on students with IEPs, former Limited English Proficient (LEP) students, and the class as a whole. It is important to note that all student populations saw a significant increase in average semester grades. The class population of Physical Science saw an average increase of ~10 percentage points when the supports were implemented between the 2018-2019 school year and the 2019-2020 school year. No significant change is noted between the semester grades of students in the 2019-2020 and 2020-2021 school year when the supports were implemented in an online and hybrid learning environment. All three student populations experienced similar increases in student grades. IEP students and LEP students saw grade increases that matched closely with the rest of the experimental group.

Results from a district-based science assessment were also taken to measure the efficacy of the treatment on student achievement. This assessment measured students' ability to analyze data sets and draw conclusions.

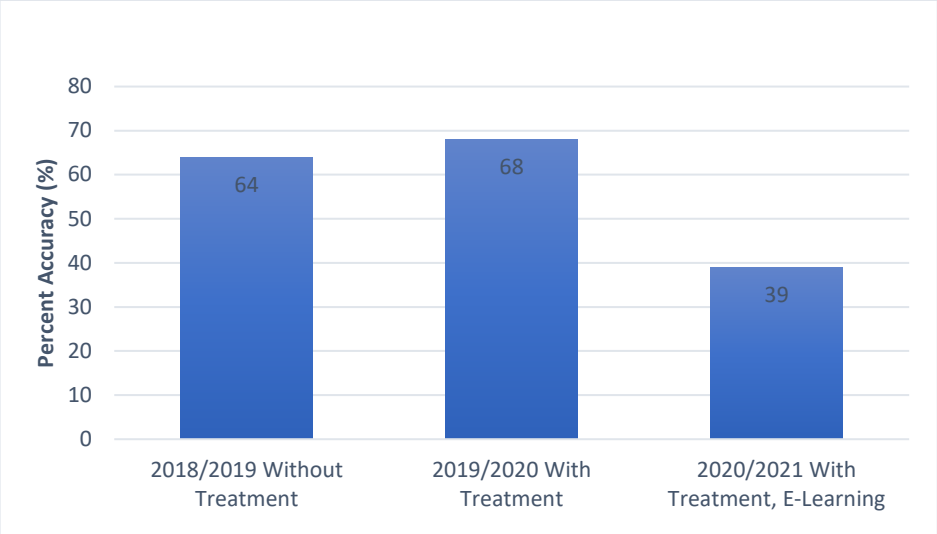


Figure 2. District based science assessment results.

Student scores on this assessment improved from 18.19 to 19.20 by an average of four percentage points. However, the 50 students who received the classroom supports in a regular classroom environment (M = 16.39, SD = 4.74) compared to the 28 participants in the control group (M = 15.35, SD = 5.00) did not demonstrate statistically significant better testing scores, t(49) = -0.8, p = .21. Student scores on this assessment decreased significantly in the 20.21 school year. It is important to note that the assessment was given as part of the semester exam in the 18.19 and 19.20 school years but was used in the 20.21 school year as a post-test with no impact on student grades. Due to modifications in the curriculum necessitated by the remote learning environment, students in the 20.21 school year received significantly less laboratory instruction and had fewer opportunities to analyze data sets.

Class Culture

Survey data was considered in measuring the impact of the mindfulness based social emotional learning curriculum on classroom culture. Seventeen students provided data for this survey. As part of the survey, two Likert style questions were asked, each regarding student sense of belonging in the classroom. Students were asked to rate their agreement with a statement from 1 to 5. The statements were "I feel known in my other classes" and "I feel known in this class." Students rated their agreement with the first statement about their belonging in other classes with an average score of 3.76, indicating agreement but not necessarily strong agreement. Students rated their agreement with the second statement about their sense of belonging in Physical Science with an average score of 4.18. This data indicates that the supports provided in Physical Science positively impacts students' sense of belonging in the classroom, a key aspect of classroom culture. Students were also asked to rate their excitement about coming into class, 13 out of the 17 students who responded agreed with the most positive answer choice to this question "I am very excited to come into Physical Science" with three of the remaining four students agreeing with the statement "I like coming into Physical Science." Only one student reported indifference about coming into the class.

Attendance data was also considered to measure the impact of the treatment. Student attendance to Physical Science was compared to that of other classes. For this measurement, the attendance data of the entire class (N=27) was measured. For each student, the total number of truancies (unexcused absences) to classes other than Physical Science was divided by the number of other classes in which the student was enrolled. This was compared to the number of Physical Science classes missed. It was found that

on average, students were truant to other classes 4.38 times per semester. Comparatively, students were truant to Physical Science an average of 3.15 times per semester. Taken as a whole, students have been slightly less likely to skip their Physical Science course than to skip the other courses in which they are enrolled.

The third measure of class culture is referral data. Referrals were written when students were deemed unsafe to remain in the classroom or when they exhibited behavior that required consequences beyond what could be enforced in the classroom. Larger numbers of referrals correspond with greater behavioral issues exhibited in the classroom. In the 2018-2019 school year, twenty-seven referrals were written for one class (N=23). The following year, as the mindfulness and social emotional learning supports were implemented, nine referrals were written for two classes (N=55). Before the treatment, three times the number of referrals were written for less than half of the number of students. In the 2020-2021 school year, no referrals have been written for the one class considered (N=27).

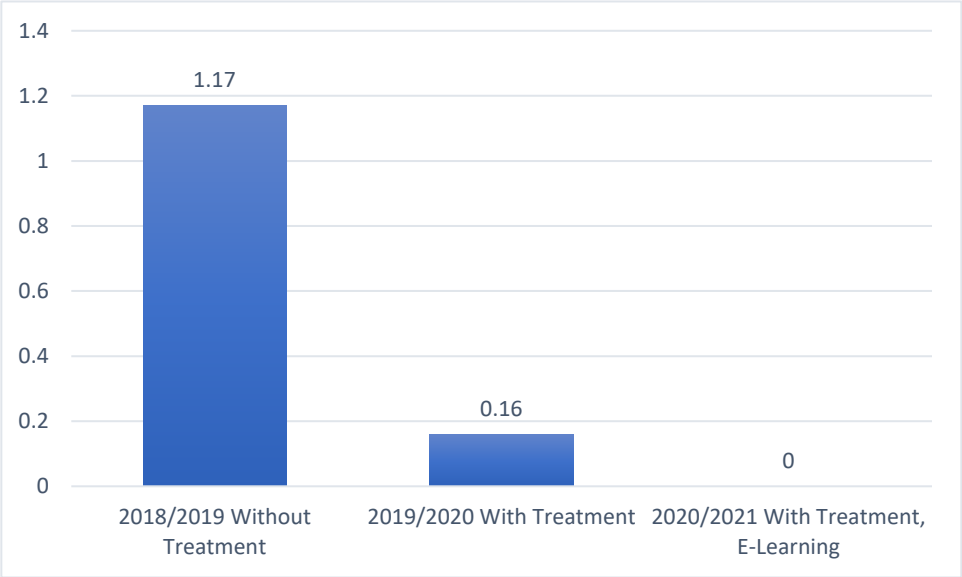


Figure 3. Referral data per student.

Figure 3 shows the average number of referrals per student over the past three school years. It is clear from this data that the implementation of the treatment significantly reduced the number of behavioral incidents that necessitated referrals.

Student Self-Efficacy

To measure the impact of the treatment on student self-efficacy, the Self Efficacy Formative Questionnaire was given to students at the beginning and the end of the first semester of the 2020-2021 school year. Fifteen students participated in both the pre-assessment as well as the post-assessment and only the results from students who took both assessments are reported. The assessment is a Likert style survey with 13 questions. Students were asked to rate their agreement with statements on a 1-5 scale (1= Strongly Disagree, 2= Disagree, 3= Neutral, 4= Agree, 5=Strongly Agree). Each statement is a positive statement such as “If I practiced every day, I could develop just about any skill”. Agreement with each statement represents high student self-efficacy. The survey can be

subdivided into two parts. The first eight questions refer to a student's belief in their personal ability and the remaining five questions refer to a student's belief that their ability grows with effort.

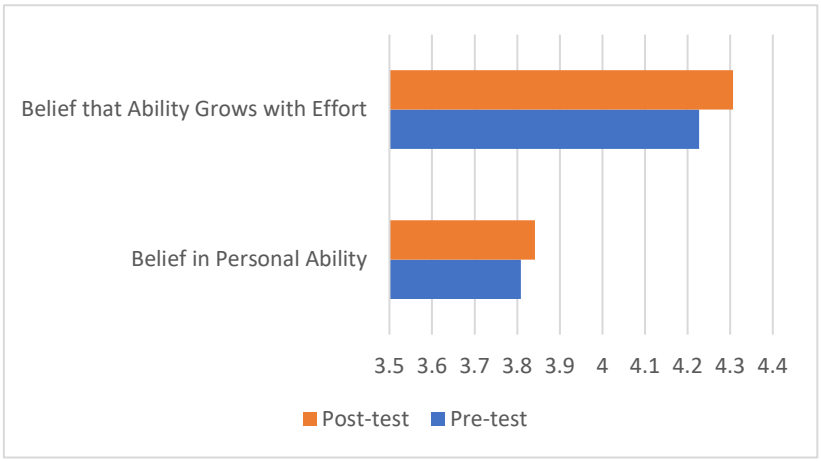


Figure 4. Student self efficacy survey results.

Though the gains were marginal, students did report higher self-efficacy at the end of the treatment. The largest gain was observed in student responses to the prompt "If I practiced hard enough, I could develop just about any skill", increasing from an average score of 3.33 to 3.93.

The second Likert style survey given to students regarding self-efficacy was the Science Interest Questionnaire. This questionnaire contains eleven questions and is used to measure a student's interest in science both in and outside of the classroom. The questionnaire was separated into two main sections, questions regarding student science interest and questions regarding student science self-efficacy. Results from this survey are tabulated below in Figure 5.

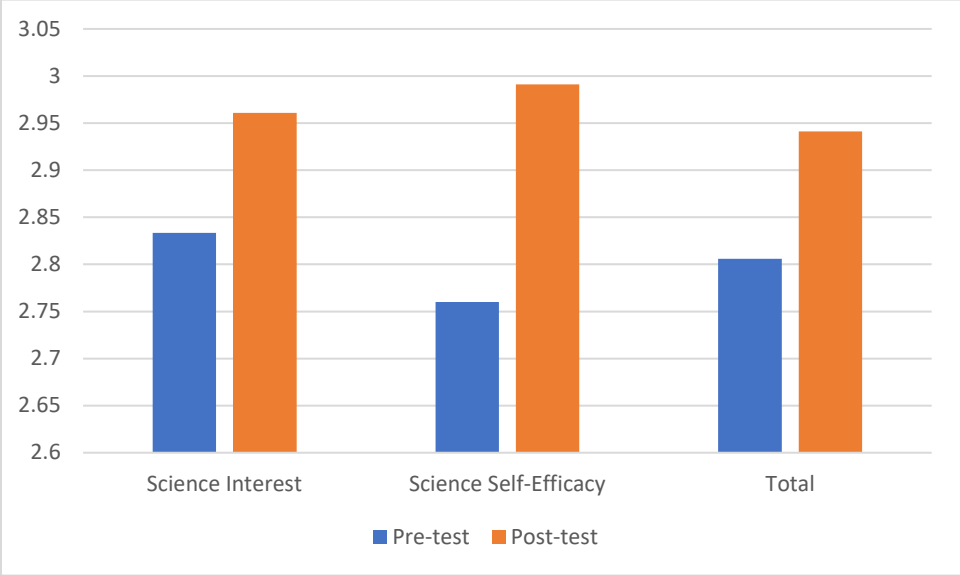


Figure 5. Science interest questionnaire pre- and post-test data.

From this data, it is clear that students made marginal gains in both their science interest and their science self-efficacy. The impact of the semester on student science self-efficacy was greater than that on student science interest. This is a predictable outcome as the supports of mindfulness and SEL curriculum specifically target student self-efficacy.

It should be noted that the timing of the pre- and post-surveys most likely played a role in the results collected. The pre-survey was given at the beginning of the school year when student energy and positive attitudes are generally high. The post-surveys were given near the end of a semester of remote learning. The positive impact of the supports may have been greater than the data depicts.

A student interview was conducted to determine how the supports impacted student self-efficacy. In this brief interview, students were asked to report how the mindfulness and social emotional learning lessons impacted them in and outside of the

classroom. Students generally reported feeling more relaxed and ready to learn in class after mindfulness exercises with one student saying, “After mindfulness, I’m usually more relaxed than when I first came into class.” Another student agreed saying “It helps me chill out” and a third noted that it helped her have “more concentration on the class.” One student noted that he used the mindfulness strategies after school as well saying, “I would use the breathing before I would go and dive for meets”. After the group interview concluded, a student privately mentioned that the mindfulness and SEL lessons had become a coping strategy for her anxiety. She said, “They have helped me calm myself when I was scared”.

From this interview, a few major themes emerged. When asked, every student in the small group reported that they experienced a decreased level of anxiety and increased focus on the days that we practiced mindfulness techniques. Students also reported appreciation for the time taken out of class to talk about subjects outside of the scope of the class curriculum. As noted in the Conceptual Framework of this paper, including time to talk about non-curricular topics is a technique that infuses SEL into classroom curricula and practices. One student expressed appreciation plainly, stating, “My favorite part of our class is when we talk about what we did or what we are doing in our weeks!” When this was said, the other four students agreed and noted that it was a highlight of the class for them as well.

When asked specifically about their perceived ability to achieve success, all five students reported that they felt that they could be successful in Physical Science. One student noted, “I normally hate science but this year I feel like I get it better.” Another

student reported, “I feel like I understand stuff in this class because we’re more involved than just doing worksheets and stuff.” In each case, students generally communicated an increase in their self-efficacy in Physical Science.

CONCLUSION

Claims From the Study

This research set out to determine the impact of mindfulness and Social Emotional Learning Curriculum in the general education science classroom. Specifically, the study noted the impact on student achievement, classroom culture, and student self-efficacy. Multiple sources of qualitative and quantitative data were collected and analyzed with a variety of different methods.

Mindfulness and SEL Improves Academic Performance

Based on semester grade data, data from a pre- and post-assessment, and data from a district-based science assessment, it is clear that the mindfulness and Social Emotional Learning supports were beneficial to student academic achievement. Student semester grades increased by over ten percent when the supports were conducted in an in-person environment and by nearly eight percent in an online environment as compared to a control group. The change to an online environment is the most likely cause of the decrease in student semester grades from the 2019-2020 school year to the 2020-2021 school year. Even with this decrease, it is clear that the supports helped improve student semester grades. An increase in student semester grades indicates a higher level of work completion and performance on assessments.

As they were provided with mindfulness and SEL lessons, students improved their understanding of science content. This was demonstrated by a statistically

significant increase in scores from a pre-assessment to a post-assessment on the Forces unit.

Students who were provided mindfulness and SEL supports increased their performance on a district-based science exam. However, this was only true for students who experienced the class in an in-person environment. Students who experienced the classroom activities and supports in an in-person environment in the 2019-2020 school year demonstrated a four percent increase in scores on this assessment. This increase, however, was deemed statistically insignificant when subject to an unpaired t-test. It is noted that there was a significant decrease in student scores in the 2020-2021 school year. Due to the coronavirus pandemic and online learning in the 2020-2021 school year, students were not able to conduct the laboratory experiments that specifically prepared them for this exam. Further, in previous years, the assessment was given as a final exam. No final exams were given in the 2020-2021 school year and the assessment was given as an in-class assignment. It is assumed that the decrease in student achievement on this assessment is due to these factors rather than the supports provided.

Taken together, it is clear that the supports significantly increased student achievement. This is true for semester grades, unit assessments, and, when the class was provided in an in-person learning environment, a district-based science assessment. These results are consistent with many previous studies into the impact of SEL curricula on student achievement (Durlak, 2011). The results are also connected to previous research done on the positive impact of mindfulness on attention span, a key component to a student's ability to learn new information (Gutierrez et al., 2019).

Mindfulness and SEL Improves Classroom Environment

Even more notably, the supports provided positively impacted the classroom environment. The student survey results show that students felt a higher sense of belonging in the Physical Science classroom in which they were provided with mindfulness and SEL supports than in their other classes. They also suggest that student genuinely desired to come to the class with all but one student reporting excitement to come into class. These survey results are specifically impactful in a year in which students participated in class from home and interacted with others through a screen.

The results of this survey also follow the research done by CASEL on the impact of SEL curricula on student behavior and positive social behavior in the classroom (CASEL, 2015).

Attendance data also shows the positive impact of these supports on classroom culture. Student attendance was specifically higher in the classroom studied than in the other classes that the same student population attended throughout the school. Positive classroom culture is reflected by higher student attendance because it shows that students feel comfortable coming into class or joining via zoom.

Student referral data also demonstrates the positive trend in classroom culture. It is noted that significantly fewer referrals were written in classrooms provided mindfulness and SEL supports than in the control group. In an online learning environment, student interactions and behavioral issues are significantly reduced. Thus, this improvement is particularly notable in the difference between the 2018-2019 and 2019-2020 school years. In these years, all outside environmental factors were the same

but the number of referrals in the classroom was reduced by nearly 10 times. The decrease in student problem behaviors is expected. This impact has been documented in previous research (CASEL, 2015). Further, these supports are specifically targeted towards decreasing student stress levels and modeling positive relationships. It is expected that students who feel less stressed and understand how to interact appropriately with their peers will engage in fewer problem behaviors.

Mindfulness and SEL Improves Student Self-Efficacy

After being provided mindfulness and SEL supports, student self-efficacy was noted to improve by a small margin. Two student surveys from the beginning and end of the classroom treatment were analyzed. In both the self-efficacy formative questionnaire and the science interest questionnaire, a marginal increase in student self-efficacy was measured. Students also reported positive impacts from the mindfulness and SEL lessons in a student interview conducted after the treatment.

The observed increase in student self-efficacy aligns with the research done by Taylor, Oberle, Durlak, and Weissberg which demonstrated the impact of SEL curricula on academic and life outcomes. Their findings note an increase in positive life outcomes consistent with high academic self-efficacy such as graduation rates and college attendance. SEL curricula is meant to model appropriate relationships with self and with others. Mindfulness practices help decrease stress hormones in the body and help the brain focus. Both practices are understood to increase student academic achievement Increased self-efficacy is a predictable result of these effects.

Value of the Study and Consideration for Future Research

Mindfulness and Social Emotional Learning supports help develop student coping skills and increase their ability to learn and engage in positive social interactions. Though many studies have been done on the impact of these two supports, this study specifically measured their effect as they were used together. When implemented concurrently in the science classroom, they increased student engagement and improved the academic outcomes of the students involved.

Not only does this project add to the growing body of research into mindfulness and SEL supports in educational environments, it also has improved the level of instruction and academic outcomes in multiple classrooms across Conant High school. Data and ideas from this study have been presented to first- and second-year teachers throughout the building and have been presented in breakout sessions available to all teachers during an institute day.

Further research in this area will involve continued implementation of these supports as students return to school after a year of online and hybrid learning. Students coming back from the isolation of learning from home will need specific supports to reacclimate to the school environment. Further research will involve incorporating these supports and noting the impact on affected students. A more diverse set of SEL lessons will be implemented to help students readjust to constant social interactions and their efficacy will be analyzed.

Other topics for research could include the incorporation of these supports in honors and AP level classrooms. The classroom studied was a lower-level science class and further research must be done to indicate its efficacy with other level classes.

Impact of Action Research on the Author

The research involved in this study has had a dramatic impact on my focus as an educator. In providing mindfulness and Social Emotional Learning supports, I was forced to give up time on science content. My focus had to shift from simply supporting the academic growth of my students to supporting the whole person of those sitting in my classroom. I found that in doing so, my relationships with students were significantly stronger and I felt genuine excitement coming into class every day. On top of these things, I found that my students were beginning to pay closer attention during the lessons, and by the end of the semester, we had covered the same content as in years past and students performed better on assessments than ever before.

I also found that my empathy for my students grew significantly as I incorporated these supports. SEL lessons often allow space personal stories and time for community building. Throughout the years that I have implemented mindfulness and SEL lessons, students became more open and honest, coming to me and their classmates for advice and support.

Taken together, I cannot say enough about the positive impact that implementing these supports has had on me as an educator. I hope to continue to improve my practice and support students for years to come.

REFERENCES CITED

Brackett, M. A., & Rivers, S. E. (n.d.). Transforming students' lives with social and emotional learning. *International Handbook of Emotions in Education*. doi: 10.4324/9780203148211.ch19

CASEL. (2015). Effective social and emotional learning programs. *Casel Guide*. http://secondaryguide.casel.org/casel-secondary-guide.pdf

Durlak, J. A., Weissberg, R. P., Dymnicki, A. B., Taylor, R. D., & Schellinger, K. B. (2011). The impact of enhancing students' social and emotional learning: A meta-analysis of school-based universal interventions. *Child Development*, *82*(1), 405–432. doi: 10.1111/j.1467-8624.2010.01564.x

Felver, J.C., Jennings, P.A. (2016) Applications of mindfulness-based interventions in school settings: An introduction. *Mindfulness 7*(1–4). https://doi-org.proxybz.lib.montana.edu/10.1007/s12671-015-0478-4

Gaumer Erickson, A.S., Soukup, J.H., Noonan, P.M., & McGurn, L. (2018). *Self-efficacy formative questionnaire technical report*. http://www.researchcollaboration.org/uploads/Self-EfficacyQuestionnaireInfo.pdf

Gueldner, B. & Feuerborn, L. (2015). Integrating mindfulness-based practices into social and emotional learning: A case application. *Mindfulness.* doi: 7. 10.1007/s12671-015-0423-6.

Gutierrez, A. S., Krachman, S. B., Scherer, E., West, M. R., & Gabrieli, J. D. E. (2019, January). Mindfulness in the classroom: Learning from a school-based mindfulness intervention through the Boston Charter Research Collaborative.

Transforming Education. https://www.transformingeducation.org/wp-content/uploads/2019/01/2019-BCRC-Mindfulness-Brief.pdf

Keng, S. L., Smoski, M. J., & Robins, C. J. (2011, August). *Effects of mindfulness on psychological health: A review of empirical studies*. Clinical psychology review. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3679190/.

Langer, Álvaro I., Ulloa, Valentina G., Cangas, Adolfo J., Rojas, Graciela, & Krause, Mariane (2015). Mindfulness-based interventions in secondary education: A qualitative systematic review. *Studies in Psychology*, *36*(3), 533-570, doi: 10.1080/02109395.2015.1078553

Oliver, B. (2018). Social emotional learning toolkit. https://www.doe.in.gov/sites/default/files/sebw/sel-toolkit-final-updated-cover.pdf.

Performance Descriptors for Social Emotional Learning. (n.d.). https://www.isbe.net/Documents/descriptors_6-12.pdf

Salmons, H., & Smith, C. (2018). A combined approach to summer, SEL, and STEM in Boston and Providence. In 1073389806 816425481 E. Devaney & 1073389807 816425481 D. Moroney (Authors), *Social and emotional learning in out-of-school time: Foundations and futures* (pp. 73-86). Charlotte, NC: Information Age Publishing.

Taylor, R. D., Oberle, E., Durlak, J. A., & Weissberg, R. P. (2017). Promoting positive youth development through school-based social and emotional learning

interventions: A meta-analysis of follow-up effects. *Child Development, 88*, 1156-1171. doi:10.1111/cdev.12864

Walls, J. W. (2012). Physics through collaboration. https://scholarworks.montana.edu/xmlui/bitstream/handle/1/2493/WallsJ0812.pdf?sequen ce=1&isAllowed=y

APPENDICES

APPENDIX A

IRB APPROVAL FORM

MONTANA STATE UNIVERSITY

INSTITUTIONAL REVIEW BOARD
For the Protection of Human Subjects
FWA 00000165

2155 Analysis Drive
c/o Microbiology & Immunology
Montana State University
Bozeman, MT 59718
Telephone: 406-994-4706
FAX: 406-994-4303
E-mail: cheryl@montana.edu

Chair: Mark Quinn
406-994-4707
mquinn@montana.edu
Administrator:
Cheryl Johnson
406-994-4706
cheryl@montana.edu

MEMORANDUM

TO: Caleb Cochrum and Marcie Reuer

FROM: Mark Quinn Mark Quinn CTJ
Chair, Institutional Review Board for the Protection of Human Subjects

DATE: November 9, 2020

RE: *"Mindfulness-Based Social Emotional Learning in the Science Classroom" [CC110920-EX]*

The above research, described in your submission of November 8, 2020, is exempt from the requirement of review by the Institutional Review Board in accordance with the Code of Federal regulations, Part 46, section 101. The specific paragraph which applies to your research is:

X (b) (1) Research conducted in established or commonly accepted educational settings, involving normal educational practices such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

X (b) (2) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation; and (iii) the information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by section 16.111(a)(7).

___ (b) (3) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior that is not exempt under paragraph (b)(2) of this section, if: (i) the human subjects are elected or appointed public officials or candidates for public office; or (ii) federal statute(s) without exception that the confidentiality of the personally identifiable information will be maintained throughout the research and thereafter.

___ (b) (4) Research involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available, or if the information is recorded by the investigator in such a manner that the subjects cannot be identified, directly or through identifiers linked to the subjects.

___ (b) (5) Research and demonstration projects, which are conducted by or subject to the approval of department or agency heads, and which are designed to study, evaluate, or otherwise examine: (i) public benefit or service programs; (ii) procedures for obtaining benefits or services under those programs; (iii) possible changes in or alternatives to those programs or procedures; or (iv) possible changes in methods or levels of payment for benefits or services under those programs.

___ (b) (6) Taste and food quality evaluation and consumer acceptance studies, (i) if wholesome foods without additives are consumed, or (ii) if a food is consumed that contains a food ingredient at or below the level and for a use found to be safe, or agricultural chemical or environmental contaminant at or below the level found to be safe, by the FDA, or approved by the EPA, or the Food Safety and Inspection Service of the USDA.

Although review by the Institutional Review Board is not required for the above research, the Committee will be glad to review it. If you wish a review and committee approval, please submit 3 copies of the usual application form and it will be processed by expedited review.

APPENDIX B

SCIENCE INTEREST QUESTIONNAIRE

1. I am interested in science ideas if I see them on TV
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

2. I take science courses because I like to, not because I need to
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

3. Science and technology subjects are discussed at home
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

4. My friends and I talk about science and technology
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

5. I am more interested in learning science than my science grade
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

6. I think that knowing science facts will help me in my everyday life
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

7. I imagine myself working in a lab or doing science field research
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

8. I am good at retaining science concepts when I learn them
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

9. I read books about facts, not fiction
   ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

10. Understanding science makes me feel smarter than other subjects
    ◇Always ◇Often ◇Sometimes ◇Rarely ◇Never

APPENDIX C

SELF-EFFICACY FORMATIVE QUESTIONNAIRE

1. I can learn what is being taught in class this year.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

2. I can figure out anything if I try hard enough.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

3. If I practiced every day, I could develop just about any skill.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

4. Once I've decided to accomplish something that's important to me, I keep trying to accomplish it, even if it is harder than I thought.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

5. I am confident that I will achieve the goals that I set for myself.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

6. When I'm struggling to accomplish something difficult, I focus on my progress instead of feeling discouraged.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

7. I will succeed in whatever career path I choose.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

8. I believe hard work pays off.

   ◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

9. My ability grows with effort.

◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

10. I believe that the brain can be developed like a muscle.

◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

11. I think that no matter who you are, you can significantly change your level of talent.

◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

12. I can change my basic level of ability considerably.

◇Strongly Agree ◇Agree ◇Neutral ◇Disagree ◇Strongly disagree

APPENDIX D

EXAMPLE SEL LESSON

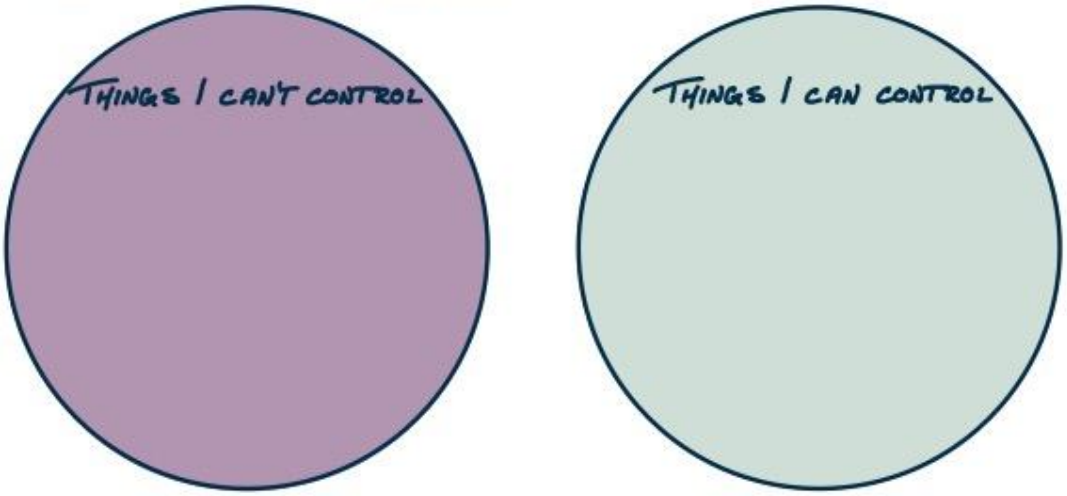
STRESS RELIEF!

After watching this wellcast video:https://www.youtube.com/watch?v=0fL-pn80s-c fill out the following questions.

WRITE DOWN A FEW THINGS THAT ARE CAUSING YOU STRESS.

-
-
-
-

SEPARATE THESE THINGS INTO...



1) WHAT IS ONE PRACTICAL STEP TOWARDS SOLVING AN ISSUE LISTED IN THE GREEN CIRCLE?

_____

_____

2) WHAT IS ONE STRESS RELIEF STRATEGY FROM THE VIDEO THAT YOU WILL TRY?

_____

_____

APPENDIX E

EXAMPLE MINDFULNESS SCRIPT

Deep Breathing Exercise:

Each day we are going to take a moment to breathe and relax so we can be present in this class. I know it can feel weird or awkward or funny, I just ask that you are respectful and remain silent, its only for 10 seconds or so. This is something that you can do when you are getting stressed or overwhelmed and it will help to calm you down.

Get in a comfortable position and close your eyes. Try to focus on your breathing. Breathe in for three seconds 1-2-3. And breathe out for three seconds 1-2-3. Breathe in 1-2-3, breathe out 1-2-3. In 1-2-3, and out 1-2-3. 1-2-3, and 1-2-3. 1-2-3, and 1-2-3. Ok you can open your eyes. This is a safe place and were going to try to learn and have fun today.

APPENDIX F

SAMPLE SEL LESSON CASE STUDY

Golden Rule Case Study

This is a real situation that I watched when I was a camp counselor at a summer English camp. Read what happened and determine who was in the wrong in this scenario.

Student A was sitting at the lunch table and mumbled a statement. Student B, not understanding what he said, took this statement to be derogatory and called Student A a jerk. Reacting to this, Student A asked “Do you want to fight me?” at which point Student B stood up and flipped Student A’s tray of food over. The two students were then pulled apart before they could wrestle each other to the ground.

Who was wrong and why?

APPENDIX G

FORCES TEST

Forces Test Name _____

1 2 3 4 5 6 7 8

Identify the choice that best completes the statement or answers the question. You may write on this test.

1. The law that states that every object maintains constant velocity unless acted on by an unbalanced force is
   a. Newton's first law of motion.
   b. Newton's second law of motion.
   c. Newton's third law of motion.
   d. the law of conservation of momentum.

2. The law that states that for every action force there is an equal and opposite reaction force is
   a. Newton's first law of motion.
   b. Newton's second law of motion.
   c. Newton's third law of motion.
   d. the law of conservation of momentum.

3. The law that states that the total force acting on an object equals the object's mass times its acceleration is
   a. Newton's first law of motion.
   b. Newton's second law of motion.
   c. Newton's third law of motion.
   d. the law of conservation of momentum.

4. What is the unbalanced force that slows down a ball rolling across the floor?
   a. the force of friction
   b. the force of gravity
   c. the force of inertia
   d. the force of momentum

5. Which object has the greatest mass?
   a. a tennis ball
   b. a bowling ball
   c. a beach ball
   d. a volleyball

6. Which of the following objects will experience a gravitational force on earth?
   a. a bowling ball
   b. a book
   c. a feather
   d. All of the above

7. When an object is freely falling without air resistance, the only force acting on it is
   a. gravity.
   b. friction.
   c. inertia.
   d. terminal velocity.

8. Ook pushes on Grog, Newton's third law says that at the same time, Grog pushes on Ook with a force that is _____ in size, and _____ in direction.
   a. equal, same
   b. smaller, same
   c. equal, opposite
   d. smaller, opposite

9. The SI unit of force, named after the scientist who described the relationship between motion and force, is called the
   a. newton.
   b. meter.
   c. joule.
   d. Watt

10. A cup is placed on a table. It pushes on the table. What is the reaction force?
   a. the force of the cup on the table
   b. the force of the table on the cup
   c. the force of gravity on the table
   d. the force of gravity on the cup

11. Which of the following units is used to measure acceleration?
   a. m/s
   b. m*s
   c. m/s/s
   d. m*m/s/s

12. Which of the following units is used to measure force?
   a. m/s
   b. N
   c. m/s/s
   d. kg

13. A crash dummy will fly through the front window of a car in a crash test because…
   a. There is a force acting on the dummy pushing it forward
   b. The dummy has inertia
   c. The dummy wanted to
   d. The dummy has constant speed

14. A truck moves to the right and is speeding up. The biggest force on the truck must be…
   a. To the right
   b. To the left
   c. Up
   d. Down

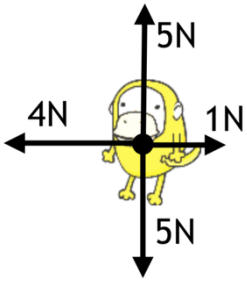
15. A rocket moves upwards and is slowing down. The biggest force on the truck must be…
   a. To the right
   b. To the left
   c. Up
   d. Down

16. What force must be applied to make a 15 kg object accelerate at a constant rate of 2 m/s/s?
    a. 7.5 N
    b. 30 N
    c. 0.133 N
    d. 17 N

17. A ball is pushed with 35 N of force and accelerates at 7 m/s/s. What is its mass?
    a. 5 kg
    b. 42 kg
    c. 0.2 kg
    d. 245 kg

18. If Lorena pushes on a 20 kg box with 10 N of force, how fast will it accelerate?
    a. 2 m/s/s
    b. 0.5 m/s/s
    c. 30 m/s/s
    d. 200 m/s/s

For questions 19 and 20, consider the monkey at right.



19. What is the total force on this monkey?
    a. 15 N
    b. 4 N
    c. 3 N
    d. 10 N

20. The mass of the monkey is 1 kg. What is the monkey's acceleration?
    a. 1 m/s/s
    b. 3 m/s/s
    c. 4 m/s/s
    d. 10 m/s/s

Free Body Diagrams

Match the free body diagrams with the situations on the right.

21. 

22. 

23. 

a. A falling ball 

b. A pushed box 

c. A hanging weight 

24. What is the net force on this object?

a. 11 N up
b. 0 N
c. 3 N right
d. 3 N left