

A Seminar Paper

The attached seminar paper, by Marcie Ingham, titled, **The Relationship Between STEM Opportunities and Student Perseverance**, when completed, is to be submitted to the Graduate Faculty of the University of Wisconsin-Platteville in partial fulfillment of the requirements for the Master of Science in Education Degree, for which 3 credits shall be allowed, is hereby

Approved: *Jodean E. Grunow, Ph.D.* (Electronically Signed) Date: *December 11, 2018*

THE RELATIONSHIP BETWEEN STEM OPPORTUNITIES
AND STUDENT PERSEVERANCE

A Seminar Paper

Presented to

The Graduate Faculty

University of Wisconsin-Platteville

In Partial Fulfillment of the

Requirement for the Degree

Masters of Science

in

Education

by

Marcie Ingham

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I would like to extend a sincere thank you to Dr. Jodean Grunow and Dr. Timothy Deis for opening my door into the amazing STEM world. It is largely due to their inspiration and enthusiasm for teaching, that I have incorporated so many new and exciting changes into my teaching and in my classroom. I was prompted to explore and experience learning through new means and I am a better teacher because of it. I now look for ways to incorporate STEM throughout my curriculum. I even do STEM activities with my own children now! I am grateful to have met and worked with such amazing teachers. Dr. Grunow and Dr. Deis, thank you so much for your continual support and encouragement.

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ABSTRACT

This study researched the idea of exposing kindergarten students to STEM activities to increase perseverance and problem-solving skills. “By focusing on children’s STEM learning during the preschool and earlier elementary years, we can prepare them with the underlying dispositions for STEM thinking, equip them to meet school-based outcomes, and ready them for success in a STEM-rich economy and world” (Helen Shwe Hadani, 2018). Throughout the study, students participated in a wide variety of STEM activities, were exposed to growth mindset ideas, and were introduced to words like perseverance, stamina, and determination. They worked individually and with classmates and applied the skills and techniques of a growth mindset to tackle challenges.

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CHAPTER 1

INTRODUCTION

Statement of the Problem

The problem to be addressed is, how can I help my kindergarten students to improve their perseverance? Can I increase my students' perseverance over the course of several weeks by providing STEM opportunities? By Exposing students to STEM activities, can teachers expect to see change in student perseverance?

Purpose of the Study

The purpose of my study was to examine the perseverance of my kindergarten students. In doing so, I looked at using STEM to provide foundational skills to my students. STEM lessons were incorporated in my classroom in the past and resulted in positive and increased interaction among the students as they tried to create a possible solution to the challenge at hand. We discussed what it might look like to keep trying something, even if it seemed hard. My students were encouraged to attack the problem from different perspectives and to find multiple solutions to the problem. This study allowed me the opportunity to analyze and evaluate the STEM lessons taught, how the lessons were delivered, and the impact on how the students were persevering.

Significance of the Study

This study validated the importance of STEM education in kindergarten to increase student perseverance. This study was also used to support the inclusion of STEM into the

Kindergarten curriculum. In sharing my findings, I hope to encourage my colleagues to include STEM in their classrooms. Then, it is with optimism that I would like to see STEM-related courses and content provided within our school district and STEM literacy for the Mount Horeb Area School District created.

Definition of Terms

STEM: STEM is a curriculum based on the idea of educating students in four specific disciplines — science, technology, engineering and mathematics — in an interdisciplinary and applied approach. Rather than teach the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real-world applications. (Hom, 2014).

Perseverance: [to work] through challenges, knowing that struggle creates opportunities for growth. (Jones, 2013)

Assumptions

- Kindergarten students are five or six years old
- STEM activities integrate multidisciplinary knowledge and skills
- Kindergartners have a natural inquisitive nature and want to know “why” or “how”
- Students can learn by doing
- Students can transfer knowledge from one experience to the next
- Students can use prior knowledge to improve on what they know and understand

Delimitations of the Study

The study included data collected from one kindergarten classroom in the Mount Horeb Area School District during the first three months of the 2018-2019 school year. The kindergarten class consisted of 18 students that were five or six years old at the time the data was collected. Data was collected in early September and then again in November to compare results.

Research for this study was conducted from June to December, 2018. Most of the information gathered was found online using the University of Wisconsin Libraries search engine and database. Primary and secondary sources were used and included information from journals, articles, and other reputable sources. The information gathered was reviewed, summarized, and cited to support to the hypothesis that providing STEM opportunities will increase kindergarten students' perseverance in problem-solving.

Methodology

Parents were introduced to the study at the start of the school year. Written permission was given for students' participation. Baseline data was collected within the very first few weeks of the school year. A timer was started as the students worked, and a time was recorded for how long each student stayed on task to persist in the problem-solving scenario of the STEM activity.

After the initial data was collected, perseverance was introduced and explained to the students through discussions, stories, and real-life examples. Several STEM opportunities were

provided to foster the development of perseverance for the kindergarten students over the next several months. The opportunities included STEM activities within the classroom, a Family STEM Night when kindergarten students and their families were invited to take part in STEM activities, and STEM Buddies: doing STEM activities with another kindergarten class.

Final data was then collected to use in analysis. Again, a timer was started at the beginning of the activity and a time was recorded for each student as he or she no longer displayed perseverance in problem-solving for the STEM activity.

Perseverance was measured by comparing the initial (pre-test) times to the final (post-test) times to calculate change, if any. A paired-data analysis was conducted to better understand the impact STEM may have had on the students' perseverance. The findings were summarized and recommendations were made.

CHAPTER 2

REVIEW OF LITERATURE

Recently there has been increased awareness of the need for STEM education. It is believed that students with prior STEM experience may be better problem-solvers in the real-world.

In a world that's becoming increasingly complex, where success is driven not only by *what* you know, but by what you *can do* with what you know, it's more important than ever for our youth to be equipped with the knowledge and skills to solve tough problems, gather and evaluate evidence, and make sense of information. These are the types of skills that students learn by studying science, technology, engineering, and math—subjects collectively known as STEM. (U.S. Department of Education)

The hands-on experience of trial and error, testing out hypotheses, and looking for multiple or alternate solutions can begin to build these essential skills needed to solve tough problems.

The emergence of STEM curriculum in the public K-12 educational system provides opportunities for all level learners to master skills and content important for 21st Century learning. Using a variety of activity-based learning models, students are provided opportunities to accelerate to rigorous depths of learning. Learning is facilitated so that students are encouraged to delve deeper into topics that interest them individually. Developing students' reasoning skills, critical thinking skills, creativity, and innovation through integrated and connected STEM curriculum and pedagogical practices provides equity among learners from diverse backgrounds. STEM curriculum has the potential to provide true mastery for all learners. (Meyrick, 2011)

STEM curriculum can be provided in so many different ways in a classroom. The skills and understanding of “how” to approach a challenge and the idea that there may actually be more than one solution is the most basic element of STEM education. Students can apply these basic skills throughout their education, in their careers, and in their everyday lives.

What is STEM?

What seems like play or a fun challenge to solve, is actually an experience students can learn from which students can learn. They can use prior knowledge, test out ideas, and test results without the need to succeed. It is the learning process of building, exploring, manipulating, and testing that grows understanding of how or why it worked the way it did.

The students opened their bags and pulled out the materials to build a boat: bubble wrap, pipe cleaners, straws, a cup, bowl, rubber bands, eight small pieces of wood and crayons. As the incoming sixth-graders at Scranton's Northeast Intermediate School sketched their ideas Tuesday, Lexie Konsur told them it was OK if the boats sunk or fell apart. "Failure is part of the learning process," said Ms. Konsur, an instructional technology integration specialist with the Northeastern Educational Intermediate Unit. "When you fail, you think about what you can do better. You can keep trying until you succeed." (Hall, 2016)

Failure is not the end of the challenge. Rather, this is the point at which you try again. What else could you do? What might work instead? Why didn't that part work? All of these questions are just a start to what one might consider when evaluating a challenge. Experience in STEM will give students the confidence and security to keep trying. In addition, some people would say that there isn't failure in STEM... it just didn't work this time, but it might when I make adjustments and try it again!

What separates STEM from the traditional science and math education is the blended learning environment and showing students how the scientific method can be applied to everyday life. It teaches students computational thinking and focuses on the real world applications of problem solving. As mentioned before, STEM education begins while students are very young:

Elementary school — STEM education focuses on the introductory level STEM courses, as well as awareness of the STEM fields and occupations. This initial step provides standards-based structured inquiry-based and real world problem-based learning, connecting all four of the STEM subjects. The goal is to pique students' interest. (Hom, 2014)

There is a benefit to integrating learning between disciplines. Young learners can apply the skill or knowledge to all that they are doing. Little minds do not separate math, from reading, from recess, from all the other things they do throughout the day. Those are all bits of their day in which they are thinking about what to do, how to do it, what will others think, whether other kids want to do it too, etc. They spend their entire day exploring, absorbing, acquiring, deciding, and just doing. The idea of teaching a topic that they can apply to their life fits well with the way kindergartners already think and actively learn.

Benefits of STEM in Early Education

Young children are programmed to explore and discover as a means to learning. They stack blocks to see how high it will get before toppling over. They try to fit each piece into a puzzle but may dump it all out and start over if a piece doesn't quite work.

“Concepts at the heart of STEM—curiosity, creativity, collaboration, and critical thinking—are in demand. They also happen to be innate in young children” (Chesloff, 2013). Thus, STEM can play an essential role in early education to build and reinforce perseverance and problem-solving skills. Starting STEM education at the preschool and early elementary grades will help build creative and critical thinkers.

The pace of technological and scientific change continues to accelerate, and students beginning elementary school will graduate into an innovation economy with new technologies, scientific advances, and job opportunities that did not exist a decade ago. To best prepare for this future, all students will benefit from a solid foundation in the STEM fields. (U. S. Department of Education, 2017)

Research also suggests that STEM education at an early age can promote development in young learners. “Each challenge builds children’s skills in different areas of development: language, social and emotional, cognitive, and physical” (Reed and Young, 2017).

There is conjecture that perseverance is an individual quality that young students can acquire and build to develop deeper learning.

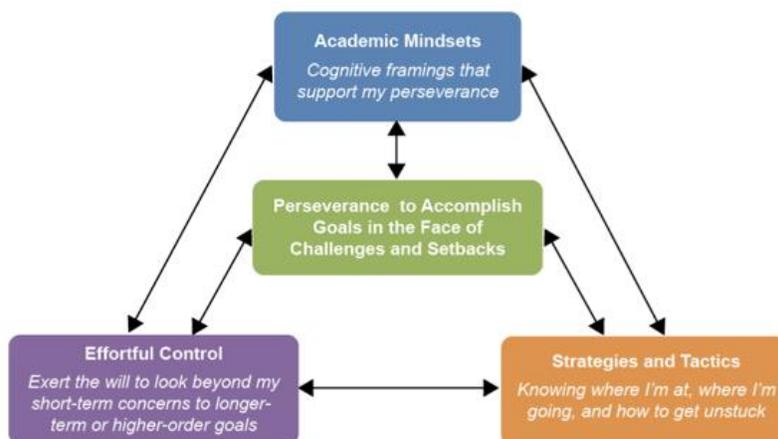
How can we best prepare children and adolescents to thrive in the 21st century? This question is at the heart of what every educator attempts to do on a daily basis. Apart from imparting content of knowledge and facts, however, it's becoming clear that the "noncognitive competencies" known as grit, perseverance, and tenacity are just as important, if not more so, in preparing kids to be self-sufficient and successful.

What Are Grit, Tenacity, and Perseverance?

Grit, tenacity, and perseverance are multifaceted concepts encompassing goals, challenges, and ways of managing these. We integrate the big ideas from several related definitions in the literature to a broad, multifaceted definition of grit for the purpose of this report: “Perseverance to accomplish long-term or higher-order goals in the face of challenges and setbacks, engaging the student’s psychological resources, such as their academic mindsets, effortful control, and strategies and tactics.”

Strategies and tactics. Students are also more likely to persevere when they can draw on specific strategies and tactics to deal with challenges and setbacks. They need actionable skills for taking responsibility and initiative, and for being productive under conditions of uncertainty—for example, defining tasks, planning, monitoring, changing course of action, and dealing with specific obstacles.

Empirically based mindset interventions include activities that explicitly teach students to have a “growth mindset” (i.e., that intelligence grows with effort), help students frame difficulty not as personal failings but as important “bumps in the road” on the way to success, provide students opportunities to affirm their personal values to maintain clarity about why they are investing their efforts, help relate course materials to students’ lives, or incorporate multiple approaches to address different needs.



In the “project-based learning and design thinking” models, students develop competencies through engagement in long-term, challenging, and/or real-world problems that require planning, monitoring, feedback, and iteration. Mindsets are addressed inherently in processes of feedback and iteration, and projects are often aligned with students’ interests and passions. (Barseghian, 2013)

This mindset can be learned, developed, and utilized. These qualities can be useful in traditional learning settings, but also outside of school, to solve problems in real-life situations, by providing experience when one is faced with a challenge. “By focusing on children’s STEM learning during the preschool and earlier elementary years, we can prepare them with the underlying dispositions for STEM thinking, equip them to meet school-based outcomes, and ready them for success in a STEM-rich economy and world” (Helen Shwe Hadani, 2018).

The need for STEM-rich individuals has created the increase in need of STEM education to create learners that are better equipped for the careers awaiting them in the near future. By incorporating STEM, we are teaching kids to be stronger problem-solvers and creative thinkers. We can teach them to persevere, look for multiple solutions, or create alternatives. We can start this at a young age to build and perfect so that they will be ready to pursue such careers later.

Perseverance

Perseverance doesn’t change overnight. There is a process and it takes time to build and grow one’s perseverance. It is gained over time, through failures and success, and is based on experiences. I can offer my young learners the chance to develop some of that grit and perseverance in the safety of our classroom and with guidance and encouragement as they learn through experiences.

First, students need to have the opportunity to take on long-term or high-order goals that, to the student, are “worthy” of pursuit. There is a wide variety of types of goals students may take on, differing in timescale and complexity, and, depending on students’ age, educational needs, the content discipline in which the goals are situated, and so on. One principle is that students find goals worthy of pursuit when they are “optimally challenging”—they require some perseverance to attain, but not so much that they seem overwhelming or impossible. Another principle is that students find goals worthy of pursuit when they are aligned with what students value. To the extent possible, goals should be designed to promote intrinsic motivation through connections to students’ interests, values, and personally relevant goals. In many cases, particularly with unfamiliar material, educators need to engage students in activities that bridge from their interests and familiar experiences to the learning objectives to help students attain more complex learning goals. Providing students with choice and autonomy in selecting goals and approaches also can foster intrinsic motivation. (U.S. Department of Education, 2013)

As a learner, you need to develop your own sense of effort and drive to be successful. You need to determine your goal, pace your effort, and build your stamina to reach your destination. With this idea, young students need encouragement to try something new. They need to feel that it is safe to not meet their goals or even to fail without consequence. Young learners will build that sense of drive through trial and error and gaining insight from experiences.

Metacognitive learning skills are attitudes, behaviors, and beliefs about learning. These skills continue to garner attention from educational researchers and policy-makers. The Office of Education and Technology (OET) at the U.S. Department of Education released a report, Promoting Grit, Tenacity, and Perseverance—Critical Factors for Success in the 21st Century, which takes a closer look at defining, measuring, and developing these skills. Grit was defined as “perseverance to accomplish long-term or higher-order goals in the face of challenges and setbacks, engaging the student’s psychological resources, such as their academic mindsets, effortful control, and strategies and tactics” (p. 15).

Because grit may play a key role in overcoming adversity, it is encouraging that grit, tenacity, and perseverance are skills that can be developed with the right supports. For example, the OET report recommends designing learning environments that provide students opportunities to take on long-term, higher-order goals aligned with their interests. These goals are optimally challenging and intrinsically motivating. Meeting them takes perseverance. By developing such skills early, students may be more likely to persevere through challenges that are bound to arise along their college and career paths. (McClarty, 2017)

My research study investigated the exposure of kindergarten students to STEM activities and the effect that such experiences had on increasing their perseverance and problem-solving skills. The expectation was that there would be an increase in perseverance, as noted in the data, when comparing the initial time lengths to the final time lengths. After reading that the OET has placed major importance on the inclusion of STEM, I was prompted and eager to incorporate even more STEM into my classroom.

Creating STEM Literacy

It was conjectured that by learning about STEM early, students would use the skills over the remainder of their education and into their careers. Perseverance would aid them when faced with challenge, in school, in careers, and in daily life decisions.

The case for facilitating and encouraging engineering thinking and learning in the preschool classroom has been met with enthusiasm from various stakeholders. Yet, there exists the daunting, practical challenge of how to include engineering within the reality of limited classroom time, given competing priorities, such as required literacy and mathematics content, which teachers must balance while still maintaining adequate time for child-directed, open-ended play. (Lippard, Lamm, Tank, & Choi, 2018)

“In recent years, STEM education—the teaching and learning of science, technology, engineering, and mathematics—has become a national priority.” (Helen Shwe Hadani, 2018)

There are many conjectures regarding young children and the potential of their learning experiences influenced by STEM, with emphasis on the importance of starting learning at an early age to increase that potential.

“Experts in education, industry, and national security all agree that there is a national imperative to graduate students with a thorough understanding of science, technology, engineering, and mathematics (STEM)” (Sneideman, 2013). This again emphasizes the importance of STEM education and the need to start early with young learners. STEM education is important for young learners, connects the disciplines of math and science, as well as creates “natural curiosity for exploration,” while forming the essential life skill of perseverance that can be applied when faced with obstacles.

CHAPTER 3

SURVEY METHODOLOGY

Participants

The participants of this study were 17 kindergarten students in the Mount Horeb Area School District. These students were 5 or 6 years old at the time the data was collected. This study was the first experience with STEM activities for most of these kindergartners.

Procedures

Prior to starting this research study, I was given consent from my building principal Rachael Johnson to conduct the research in my classroom with my kindergarten students at the Mount Horeb Early Learning Center (Appendix A).

I also met with the UW-Platteville IRB Board to review the proposed study. The IRB Board approved this study, granting me permission to conduct the research (Appendix B).

The next step was to inform the parents of my students. I wrote a letter to the families of my students. I explained my intent and purposes. I gave details and examples of the STEM activities on which we would work. I then requested permission to allow each child to participate in the study (Appendix C). I was given permission to include 17 of my 18 students in the research study.

Next, I started to incorporate STEM into our classroom. The first activity was to make a paper chain. This was an individual activity where each student was given large sheet of construction paper and asked to make the longest chain he/she could. I gave little detail or explanation and simply encouraged them to just “give it a try.” I started a timer at the

beginning of this activity. I recorded an end time for each student as he/she told me that he/she was done, whether he/she had used up their entire paper or wanted to quit. This was my initial measurement of perseverance.

Over the next several weeks we discussed perseverance, stamina, and that the many ways to face a challenge. We continued to do several STEM activities within small groups and shared the difficulties and successes with each challenge. I noted the excitement my students exhibited when participating in a STEM activity. Many students were eager to explore, share ideas, and come up with possible solutions to the given challenge.

Each student and his/her family was invited to attend a Kindergarten Family STEM Night, that Mr. Nichols and I hosted for our classrooms. The purpose of this night was to provide an opportunity for our students and their families to become aware of the importance of STEM and to explore and learn through participation and experience. Our number one objective was to increase awareness of STEM and to educate people on what STEM is, what it stands for, and why it is important. Our second objective was to get students and families involved and participating in STEM activities. By providing hands-on experiences with a STEM night we were educating and providing opportunities for family fun. This was a great chance for families to work together, while building, creating, and problem-solving. We also hoped this would prompt families to do other STEM projects at home in the future.

At our Kindergarten STEM Night each student was given a large paper bag with three “Challenge Cards” and the necessary items for each challenge. There were tables set up in the gym with tools and supplies that could be used for each challenge. Several adults and older students were on hand to help facilitate the event. The following day a STEM bag was sent

home with each student that had been unable to attend our STEM Night, so that he/she could still do the challenges with his/her family at home.

The Challenge Cards were:

Baby Bear Boats (using a small stuffed bear toy)

- The Mission: Mama and Papa Bear are stranded on a deserted island! Baby Bear (that's YOU) is on a mission to rescue them! Using the materials on the table, construct a "boat" that holds Baby Bear and floats on top of the water.
- Test out your watercraft. Make repairs if needed.
- When it floats, move on to the next challenge!
- Don't forget to take your boat and bear with you!

Puppy Parachutes (using a small stuffed puppy toy)

- The Mission: The puppies are training to be performing parachutists for a competition but do not have working parachutes. Using the materials on the table, develop and create a functioning parachute so your puppy can land softly and safely on the target.
- Test out your parachute. Make repairs if needed.
- If your puppy lands softly and safely, move on to the next challenge!
- Don't forget to take your parachute and puppy with you!

Marble Maze (using glass marbles)

- The Mission: Mr. and Mrs. Marble love to roll through corn mazes in the fall. They love mazes SO much they want to create one of their own. Using the materials on the table, create a marble maze with a START and FINISH so The Marbles can test out their rolling skills!
- Test out your marble maze. Make repairs if needed.
- If you can move your marble from the start to the finish, move on to the next challenge!
- Don't forget to take your marbles and maze with you!

Between the two classrooms, we had a total of 22 out of the 37 families attend the family STEM night. This was a 59.5% attendance rate. We also recorded the following attendance data: there were 39 children (22 kindergarten students and their siblings), 34 adults (parents), our school district Superintendent, our school district Curriculum Director, our building Principal, 1 School Board member, 4 Kindergarten teachers, 2 Kindergarten paraprofessionals, and 8 student volunteers (6 high schoolers and 2 middle schoolers).

STEM allows students of all ages to think "outside of the box" and use their higher-level thinking skills, critical thinking, cooperation, stamina, teamwork, problem-solving, and perseverance. The Kindergarten STEM Night gave us a chance to share with our families what we were doing in our classrooms.

The last STEM activity we did in our classroom as part of this study, was to create a paper chain again. This time however, each student was given a 3x5 notecard. I started a timer at the beginning of this activity and recorded the end time when each student finished by using up his/her notecard or when he/she decided to stop. This was my second (final) measurement of perseverance for each student.

The final step in the research study was to compare and analyze the data I had collected. I used a paired analysis to compare the first time to the final recorded time for each student. I calculated the change (increase or decrease) in perseverance for each student. From those results I was able to draw conclusions about the relationship between STEM opportunities and student perseverance.

Instrumentation

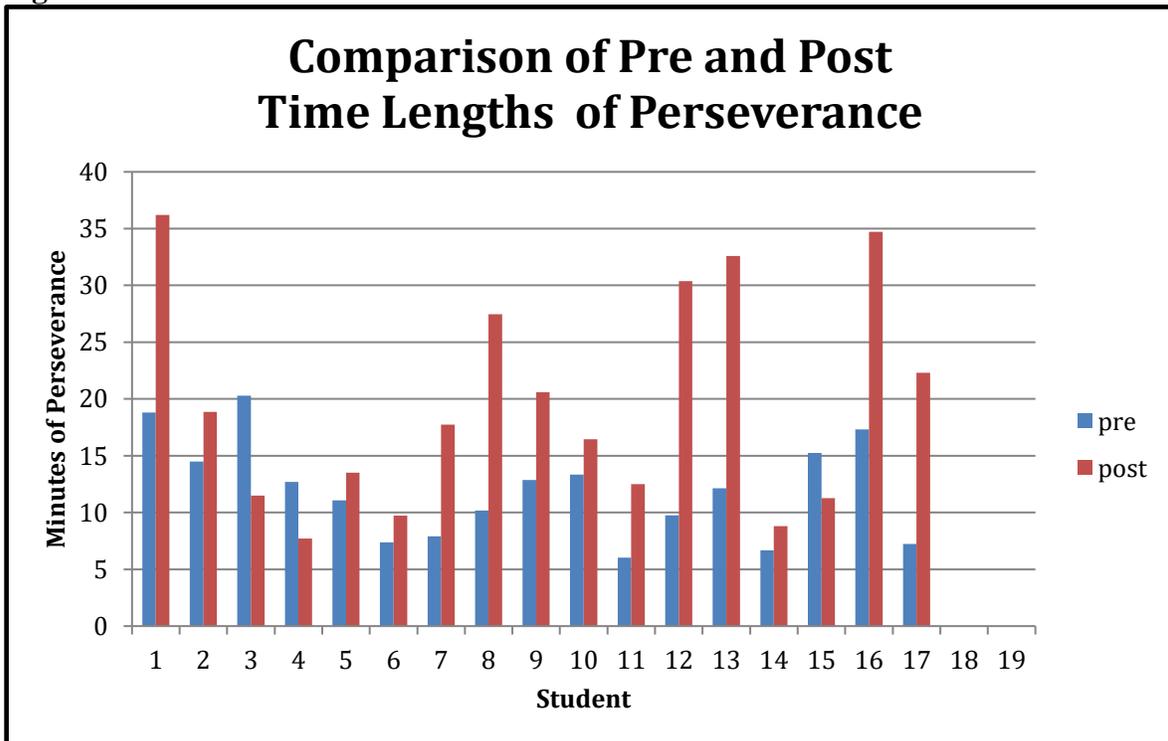
I collected data by using a stopwatch and recording ending times for each student on a chart I had created. I observed students as they were engaging in the STEM challenges. I recorded a time for each student as he/she told me they were done. I recorded the length of time, in minutes and seconds, that each student persisted in the challenge. On the recording chart, I converted each length of time into decimal hours to be used in an Excel spreadsheet. Then I used a paired analysis tool shared by Dr. Barbara Barnet from UW-Platteville. This statistical tool was used to calculate p-value and other descriptors of the data.

CHAPTER 4

ANALYSIS OF THE SURVEY DATA

After collecting the data for the initial length of perseverance and the final length of perseverance, I used a hypothesis test to determine if I had meaningful results. I used paired data since I had two sets of data, initial (pre) and final (post). After recording all the data, I put it into a formula created by Dr. Barbara Barnett (statistician, presently chair of the University of Wisconsin – Platteville Department of Mathematics) to show a comparison of the pre and post data results (t-test). The comparison of the data for each student can be seen in the bar graph below (Figure A). The data is reported on the graph for each individual student, displaying initial and final time lengths measuring perseverance in the given STEM challenge.

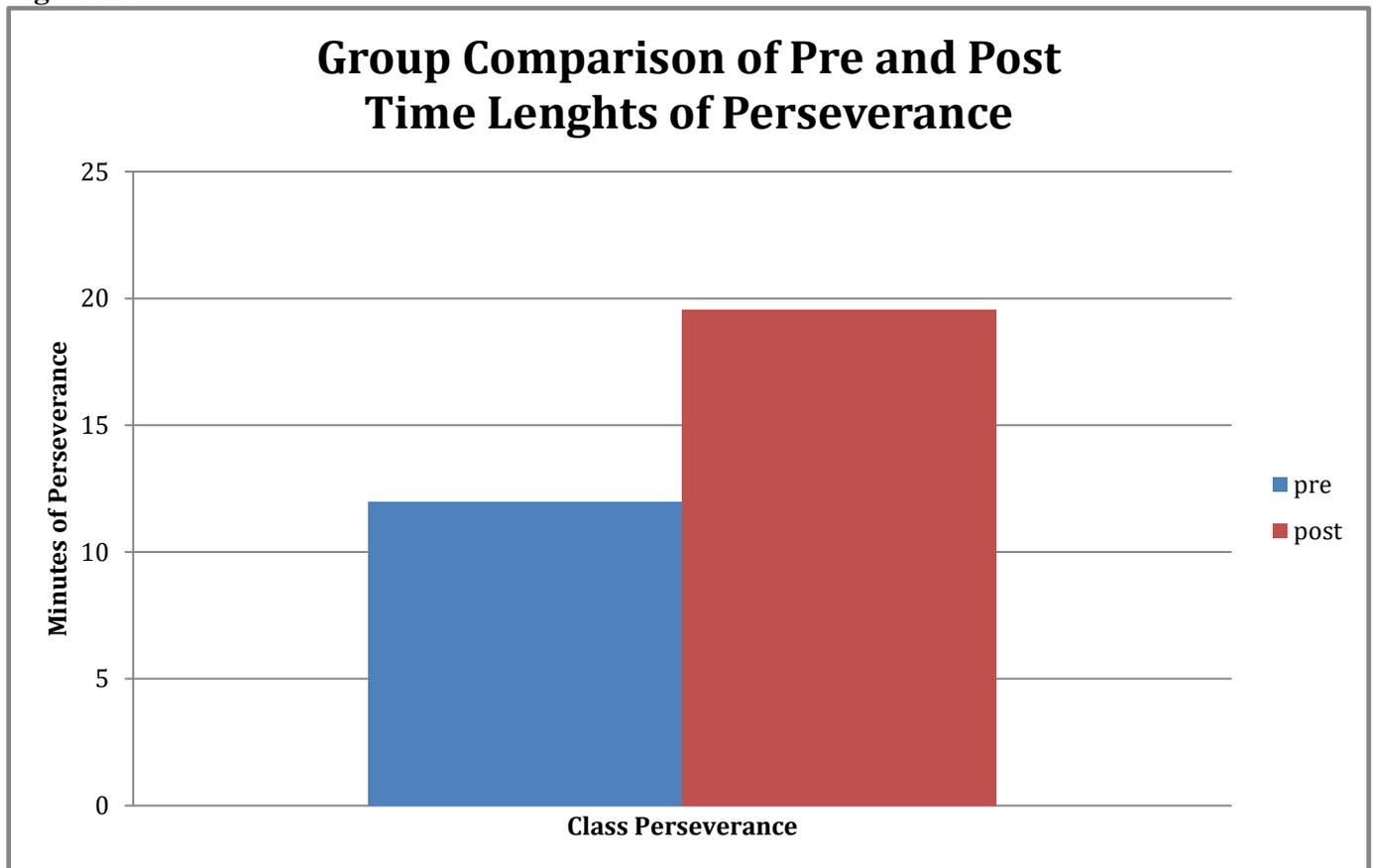
Figure A:



The comparison of the data for the whole group can be seen in the bar graph below (Figure B).

The data is reported on the graph for the average of the entire class, displaying the average initial and final time lengths, measuring perseverance in the given STEM challenge.

Figure B:



(Graphs created using Microsoft Excel spreadsheet.)

The P-value for post testing was greater, 0.0019, which means the post value was significantly higher. The P-value for testing for a difference was 0.0037 which amounted to the means being significantly different. The mean difference from the data was -7.58535294. After analyzing the P-value, the data shows that there is evidence to reject the null hypothesis and shows evidence to support my hypothesis that “exposing kindergarten students to STEM activities will increase their perseverance and problem-solving skills.”

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

After completing my research and analyzing the data I was thrilled to see the increased length of perseverance in so many of my kindergarten students. It takes practice and hard work to build the confidence of facing a challenge and trying to work through it. It would be so much easier to give up sometimes, rather than attempt to overcome the difficult issue at hand. This life skill of perseverance will benefit these children for the rest of their lives. I only hope they can continue to face a challenge with a growth mindset and the willingness to give it a try.

Throughout my study, my students participated in a wide variety of STEM activities, were exposed to growth mindset ideas, and were introduced to words like perseverance, stamina, and determination. They worked individually and cooperatively with classmates. They applied the skills and techniques we had been promoting directly to the STEM challenges I posed. I was impressed with the determination and persistence my students exuded while tackling the challenges. Their “fun” was overflowing with creativity, cooperation, and perseverance.

I conclude that student’ perseverance will increase if given opportunities to participate in STEM activities. The hands on learning that takes place in STEM education at the early elementary years will allow students to experience success and failure without judgement, but rather, the ease to transfer that learning to other challenges they will encounter in their life. The grit and stamina gained will also support their perseverance.

I recommend that STEM become a part of all early elementary classrooms. STEM education can be incorporated and connected with multiple content areas, and will allow for creativity, exploration, and the opportunity to problem solve and learn through participation. This will build student stamina and confidence in problem solving. Students will be better

equipped to tackle challenges encountered in life. Students will also recognize that there may be many different or alternate ways to attack or solve a challenge. This in itself is a life skill from which all can benefit. Including STEM education in the classroom will aid in the growth of thoughtful and critical thinkers for the future.

Including STEM in classrooms in the Mount Horeb Area School District will also help build STEM literacy for our students. After sharing my experiences and the success of this study, I would strongly encourage my colleagues to include STEM in their classroom curricula as well. I am gratified as I learn of heightened interest among other educators regarding the importance of and need to incorporate STEM into early education.

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APPENDIX A: Administrator Consent Form



ADMINISTRATIVE CONSENT FORM FOR PARTICIPATION OF HUMAN PARTICIPANTS IN RESEARCH

UNIVERSITY OF WISCONSIN-PLATTEVILLE & THE MOUNT HOREB AREA SCHOOL DISTRICT

1. **Purpose:** The purpose of this research is to examine the impact of STEM education in kindergarten to increase students' perseverance.
2. **Procedure:** Students will be asked to participate in several STEM activities over the course of the 2018-2019 school year. The STEM activities are age and developmentally appropriate for kindergarten. The study includes keeping track of the time each child participates and is actively engaged in each activity. Although STEM activities will be conducted throughout the school year, data will only be recorded initially at the start of the school year and again in November for the comparison purpose of this study.
3. **Time Required:** Participation will take place during normal scheduled classroom academic learning times. There will be no additional time required.
4. **Risks:** No short-term or long-term risks are foreseen. The only "cost" to the participants will be the time and effort required to participate in the study.

Benefits: Our class will have the opportunity to participate in many hands-on, learning activities that students often refer to as "fun" science activities. My kindergarten students will continue to learn, explore, and build stamina through participation in the STEM activities provided over the many weeks of the study. The activities will connect with other current classroom topics, themes, or areas of study.

5. **The Rights as the Parent of a Student Participant:** The information gathered in this study will be confidential. Data or summarized results will not be released in any way that could identify each child. If a child would like to withdraw from the study at any time, he/she may do so without penalty or repercussions. The information collected from the child up to that point would be destroyed if you or he/she so desires.

At the end of the study participants will be given feedback detailing the exact purpose of the research, the impact STEM had on their perseverance, and the benefit these skills may provide as they progress through school. If you have any questions afterward, please ask:

Marcie Ingham, Kindergarten Teacher
Mount Horeb Area School District, Mt. Horeb Early Learning Center
(608) 437-7116
inghammarcie@mhasd.k12.wi.us

Once the study is completed, you may request a summary of the results by contacting the above researcher.

6. If you have any questions about this study, please call or write
- | | | |
|--|----|--|
| Barb Barnet | | Dr. Jodean Grunow, Ph.D. |
| Chair of the UW-Platteville IRB | or | School of Education, Mathematics |
| (608) 342-1942 | | (608) 432-1009 |
| barnetb@uwplatt.edu | | grunowj@uwplatt.edu |

I have read the above information and (check one):

DO give consent for Marcie Ingham to conduct this research.

DO NOT give consent for Marcie Ingham to conduct this research.

Please print your full name (First, Middle, Last): _____

Signature: _____ Date: _____

APPENDIX B: IRB Board Approval Letter



9/5/2018

Marcie Ingham
Sponsor: Jodean Grunow, PH.D.
Department of School of Education,
University of Wisconsin-Platteville

RE: IRB Protocol #2018-19-02

Project Title: STEM Participation will Increase Perseverance

Approval Date: 9/5/2018

Expiration Date: 9/4/2019

Your project has been approved by the University of Wisconsin-Platteville IRB via a Full Board Review. This approval is subject to the following conditions, otherwise approval may be suspended:

1. No participants may be involved in the study prior to the IRB approval date listed above or after the expiration date.
2. All unanticipated or serious adverse events must be reported to the IRB.
3. All modifications to procedures, participant selection, and instruments used (surveys, consent forms, etc.) must be reported to the IRB chair prior to their use. Extensive modifications may require full board approval.
4. If the project will continue beyond the expiration date, then the researcher must file for a continuation with the IRB at least 14 days prior to the expiration date. If the IRB approval for this project expires before approval for continuation is given, then a new protocol must be filled out and submitted. Federal guidelines allow for no exceptions to this rule. Any data collected after the expiration date cannot be used in the study.

If you have any questions, please contact the IRB chair at the address below. Include your protocol # on all correspondence.

Sincerely,

Dr. Barb Barnet
Institutional Review Board Chair
Professor, Mathematics Department
Gardner 451
University of Wisconsin-Platteville
(608) 342-1942
barnetb@uwplatt.edu

APPENDIX C: Parental Consent Form



PARENT/GUARDIAN CONSENT FORM FOR PARTICIPATION OF HUMAN PARTICIPANTS IN RESEARCH

UNIVERSITY OF WISCONSIN-PLATTEVILLE & THE MOUNT HOREB AREA SCHOOL DISTRICT

7. **Purpose:** The purpose of this research is to examine the impact of STEM education in kindergarten to increase students' perseverance.
8. **Procedure:** Your child will be asked to participate in several STEM activities over the course of the 2018-2019 school year. The STEM activities are age and developmentally appropriate for kindergarten. The study includes keeping track of the time each child participates and is actively engaged in each activity. Although STEM activities will be conducted throughout the school year, data will only be recorded initially at the start of the school year and again in November for the comparison purpose of this study. **PARTICIPATION IS VOLUNTARY AND HE/SHE WILL BE ASKED TO GIVE HIS/HER ASSENT. YOUR CHILD'S NAME WILL NOT BE RECORDED ON THE RESEARCH MATERIALS AND IT WILL NOT BE INCLUDED IN OUR DATA SET OR IN ANY REPORTS ABOUT THE PROJECT.**
9. **Time Required:** Participation will take place during normal scheduled classroom academic learning times. There will be no additional time required.
10. **Risks:** No short-term or long-term risks are foreseen. The only "cost" to the participants will be the time and effort required to participate in the study.

Benefits: Our class will have the opportunity to participate in many hands-on, learning activities that students often refer to as "fun" science activities. My kindergarten students will continue to learn, explore, and build stamina through participation in the STEM activities provided over the many weeks of the study. The activities will connect with other current classroom topics, themes, or areas of study.

11. **Your Rights as the Parent of a Student Participant:** The information gathered in this study will be confidential. Data or summarized results will not be released in any way that could identify you or your child. If your child would like to withdraw from the study at any time, he/she may do so without penalty or repercussions. The information collected from your child up to that point would be destroyed if you or he/she so desires.

At the end of the study participants will be given feedback detailing the exact purpose of the research, the impact STEM has had on their perseverance, and the benefit these skills may provide as they progress through school. If you have any questions afterward, please ask:

Marcie Ingham, Kindergarten Teacher
Mount Horeb Area School District, Mt. Horeb Early Learning Center
(608) 437-7116
inghammarcie@mhasd.k12.wi.us

Once the study is completed, you may request a summary of the results by contacting the above researcher or Rachael Johnson, K-2 Principal.

12. If you have any questions about your child's treatment as a participant in this study, please call or write

Barb Barnet
Chair of the UW-Platteville IRB or
(608) 342-1942
barnetb@uwplatt.edu

Rachael Johnson
Mt. Horeb K-2 Principal
(608) 437-7651
johnsonrachael@mhasd.k12.wi.us

I have read the above information and (check one):

DO give consent for my child to participate in the research.

DO NOT give consent for my child to participate in the research.

Please print your child's name (First, Middle, Last): _____

Please print your full name (First, Middle, Last): _____

Signature: _____ Date: _____

*Please return this completed form to **Marcie Ingham** by Monday, **September 10, 2018**.

*Thank
you!*

Marcie Ingham
Kindergarten Teacher
Mount Horeb Early Learning Center
608.437.7116
inghammarcie@mhasd.k12.wi.us

APPENDIX D: Data Collection Chart

PROVIDING STEM OPPORTUNITIES TO INCREASE PERSEVERANCE

Research conducted by Marcie Ingham

Student	Pre-Test Initial Time	Post-Test Final Time	Pre-Test Min:Sec to decimal	Post-Test Min:Sec to decimal	Change
1	18:48	36:12	18.8	36.2	+17.4
2	14:30	18:52	14.5	18.867	+4.367
3	20:18	11:30	20.3	11.5	-8.8
4	12:42	7:42	12.7	7.7	-5
5	11:05	13:31	11.083	13.516	+2.433
6	7:22	9:44	7.367	9.733	+2.366
7	7:54	17:45	7.9	17.75	+9.85
8	10:11	27:27	10.183	27.45	+17.267
9	12:52	20:36	12.867	20.6	+7.733
10	13:20	16:27	13.333	16.45	+3.117
11	6:01	21:30	6.016	12.5	+6.484
12	9:46	30:23	9.767	30.383	+20.616
13	12:08	32:36	12.133	32.6	+20.467
14	6:40	8:48	6.667	8.8	+2.133
15	15:15	11:16	15.25	11.268	-3.982
16	17:19	34:44	17.316	34.733	+17.417
17	7:14	22:19	7.233	22.316	+15.083
18					