APPROVAL OF HONORS PROGRAM SENIOR PROJECT

Candidate

Emma Mosley

Project Title

Barriers to Implementing STEM in the K-5 Setting

This Senior Project is approved as acceptable

Project Director

Dr. Kelvin Spragley

Committee Member

Dr. Jarrod Kelly

Committee Member

Dr. Ayra Sundbom

Honors Program Co-Director

Dr. Bill Yankosky

Honors Program Co-Director

Dr. Fred Sanborn

November 25, 2025

Barriers to Implementing STEM in the K-5 Setting

Emma R. Mosley

Honors College Project

North Carolina Wesleyan University

Fall 2025

Barriers to Implementing STEM in the K-5 Setting

STEM is an acronym representative of an educational initiative started by the National Science Foundation (NSF) aimed at equipping students with the skills necessary to become expert problem solvers and essential members of the workforce in the areas of Science, Technology, Engineering, and Mathematics (White, 2). Historically, the roots of STEM in the U.S. can be traced back as far as the Industrial Revolution, but in contemporary times it has evolved dramatically following World War II. Following the Russian launch of Sputnik, Americans realized the importance and need to improve math and science education. (White, 4). Although early efforts have primarily focused on secondary and post-secondary education initiatives, contemporary research has indicated a need to begin STEM education much earlier.

STEM can be broadly classified as educational or occupational, depending on the institution. As it relates to education, STEM relates to teaching and learning through the use of instructional practices that promote STEM ideals. This includes inquiry-based learning, collaboration, and real-world applications in problem solving or problem-based learning (Breiner, et.al, 5). Each of these practices develops skills essential for a modern workforce and economy.

Current STEM educational trends are heavily influenced by the labor market and driven by economic need. The U.S. Bureau of Labor estimates that STEM occupations are projected to grow by 10.8% between 2022 and 2032, compared to just 2.3% for non-STEM occupations, with computing, engineering, and healthcare-related roles leading this growth (U.S. Bureau of Labor Statistics). Although the need is clear, a persistent gap exists as many employers report difficulties in finding laborers skilled in STEM competencies.

Due to this gap, it is vital that STEM be consistently integrated within educational frameworks beginning in the elementary years. Doing so will increase workforce readiness and ensure that the U.S. is able to remain globally competitive in STEM fields. Engaging young students, including those in elementary school, will not only boost interest but increase confidence in students' willingness and preparedness for careers in STEM fields.

While early exposure to STEM (Science, Technology, Engineering, and Mathematics) is critical for sparking a student's interest and building those foundational skills, implementing effective STEM programs in the kindergarten through fifth-grade setting is often hindered by barriers. This work will address these barriers by exploring the problem of limited teacher preparation, inequitable resources, time constraints, and the lack of community support from stakeholders. Support and systemic change are essential to realizing the full promise of early STEM education.

In addition to the growing needs, STEM has expanded as the U.S. continues to be driven by innovation and advancing technologies. According to organizations such as the National Academies and the National Science Board, an understanding of STEM is not just limited to specific fields but has become an essential part of everyday problem solving. As the country continues to evolve, the need to think critically and scientifically has now become a necessity. This growth further emphasizes the need to ensure that students receive a meaningful STEM experience in the K-5 setting.

Furthermore, these growth trends explicitly show why elementary STEM education cannot be viewed as an extracurricular activity. Instead, it must be understood as a foundational component of preparing students for their future academic and career pathways. By looking at and explaining the clear systemic barriers to STEM instruction, educators and community can

ensure that each student receives the proper resources, opportunities, and preparation needed to thrive in our evolving world.

Research Analysis

Lack of Preparedness

A significant challenge for STEM education is educators' perception of preparedness to integrate STEM into their instructional practices. This is especially true in advanced areas such as engineering and computer science. A 2018 survey underscored this idea, with just 18% of elementary school teachers feeling prepared to teach science and only 5% indicating they were comfortable with teaching engineering (Banilower et al. 29). This lack of confidence likely lies in the lack of formal STEM training and limited professional development available to teachers. Therefore, teachers have a lack of content knowledge in instructional practices that reflect strong STEM backgrounds and the preparedness to incorporate STEM in the classroom.

Time Constraints in the classroom

Along with teachers not feeling adequate to teach STEM or integrate it into the classroom, the time constraints also play a role. These teachers often face significant time pressures that limit their ability to integrate STEM instruction. So much time in the classroom is focused and devoted to the core subjects like literacy and math. But little time is left for inquiry-based activities such as STEM. With no time in the daily class schedule and no time for teachers to collaborate to design and implement high-quality STEM lessons, this important subject gets forgotten about.

Building upon this, research supports that the lack of time in the classroom is one of the most significant constraints to effective STEM integration (IEEE Xplore, 2023). Teachers in this

study reported that the tight schedule in the classroom was largely devoted to specific instruction in literacy and math. This left very limited flexibility to implement an effective and intentional STEM education. The study also showed that even with encouragement to teach STEM, they lack time to collaborate and plan for the instruction. Teachers stated they do not have consistent schedules to plan with colleagues and design STEM lessons together.

This lack of collaboration is highly problematic for integrating this instruction with high-quality standards. With the lack of collaborative work between teachers and lack of professional support, STEM becomes forgotten and pushed aside. In the study, a group of teachers tried incorporating STEM, but were having to rush through the activities or shorten them (IEEE Xplore, 2023). This takes away from the effectiveness of the instruction and does not promote the essential strategies built within STEM instruction. Finally, the research suggests that STEM risk being treated as an extracurricular rather than an essential part of the curriculum if these time constraints are not directly and explicitly addressed.

Resource Inequities in STEM Education

There is a clear disparity that exists in resource allocation. High-quality STEM instruction often depends on specialized tools, technology, and equipment, yet these resources are especially difficult to obtain in low-income or rural communities. The National Science Board (2021) reported that schools in high-poverty areas are less likely to offer hands-on or technology-based STEM courses because of persistent funding and resources inequities. This lack of access leaves teachers with few options for instruction and limits the types of STEM experiences available to students.

The persistent underrepresentation of women and minorities is a substantial challenge in STEM. Even in the elementary classroom, females receive less encouragement, fewer female role models, and fewer exposures to STEM activities. The American Association of University Women (AAUW) found that subtle biases, such as lower teacher expectations for girls in math and science, contribute to gender gaps in STEM (AAUW 14). Additionally, Black and Latino students are less likely to be encouraged or enrolled in advanced math and science courses (Education Trust 6).

Lack of community involvement from stakeholders

Understanding the perspectives of stakeholders such as teachers, administrators, and families is essential to identifying the barriers and needs surrounding effective STEM instruction in elementary schools. When looking at the barriers surrounding STEM, teachers can offer firsthand insight into the classroom. Our teachers in the classroom can provide proof of the instructional challenges regarding time constraints and lack of resources to provide effective STEM education to students. Administrations can provide a view on professional development that would help support teachers for teaching STEM. The families and community can help encourage students and provide support systems for the students and teachers.

Additionally, to expand this perspective, it is evident that each stakeholder brings a clear and necessary outlook to the understanding of effective STEM instruction and what it requires. Teachers specifically are aware of the daily challenges faced in the classroom, time constraints, lack of support, inadequate resources, and the demand on specific subjects. But they also see and know each of their students. Their experience in the classroom shows directly the struggle they must implement meaningful STEM instruction. By connecting with teachers, we are able to see a different perspective on how schools can identify what changes need to be made.

Another perspective and key aspect to STEM instruction is school administration. They play a critical role in fostering an environment that will support meaningful STEM instruction that will succeed. This includes budgeting decisions, scheduling, networking, and curriculum materials. Administrators also support teachers in the sense of encouragement, providing professional support, and specific teachers' needs in the classroom. Once administrators recognize the importance of this instruction, they can prioritize training that will encourage and build teachers' confidence in the different elements of STEM. This support will lead to collaborative planning opportunities, clear expectations, and encouragement.

Families and communities provide essential support to integrating STEM into our students' lives. Their support fosters students' confidence and engagement but will also enforce the idea that STEM is valuable even outside the classroom. Families can encourage STEM activities at home, encourage their children, and most importantly help students understand that they can do anything. While STEM can be an intimidating topic, schools and teachers can provide support such as family STEM nights to teachers, not just the students but the parents as well. Our communities offer a broader support system. They can help provide resources, role models, and hands on enrichment opportunities. When these two stakeholder groups work together, our students are supported in a way that will help them see their potential in numerous areas.

When all of our stakeholders work together, each one can work together to identify goals, barriers, opportunities, etc. in providing our students with this valuable instruction. This collaboration will provide a clear structure for students to succeed in the classroom and outside the classroom.

Conclusion

Recommendations to Break the Barriers in STEM Education

High-Quality STEM education in elementary classrooms requires intentional strategies to address these systematic barriers that hinder our students' access to STEM education. These are a few recommendations to address these barriers and put forth effort into breaking the challenges in offering STEM education.

A foundation for an effective STEM education begins with establishing a clear vision that will emphasize the importance of science, technology, engineering, and mathematics in an elementary classroom. The vision should show STEM not as an enrichment or resource class but as a fundamental part of our students' learning. We should understand that STEM does not focus just on the main parts of it but also problem solving, critical thinking skills, creativity, and teaches how to collaborate with others. By aligning this vision with goals, schools can ensure that they are fostering a culture that takes value in cultivating exploration, innovation, and curiosity.

When addressing STEM in the classroom, teachers are the central focus to make it successful. Teachers should have ongoing support and guidance to feel capable of producing high quality STEM instruction. Professional development should be intentional and specific to an elementary classroom. Many teachers do not receive proper training on how to implement STEM education into their classroom there proper and intentional training should be provided for all teachers. Creating professional learning committees (PLCs) or cohorts guided by admin or STEM mentors can help strengthen teachers’ ability to create and implement a meaningful STEM education in the classroom.

STEM education should not just exist as a subsection in the curriculum but more so it should be integrated across the whole curriculum. We can integrate these concepts across ELA, social studies, and others. This will allow students to see not only the importance but how it can apply to other real-world contexts. This will encourage critical thinking, creativity, and problem-solving skills across the curriculum and foster a positive energy towards STEM.

Appropriate access to STEM resources is essential to leveling out the playing field for all students. Districts should be supplying all schools with the tools and materials needed to produce high quality STEM instruction and engage students in hands on exploration, experiments, and innovation. If budgets are limited, schools could allow materials to be used across grade levels to ensure each classroom has what is needed. Additionally, administrators can search for grants or partnerships within their communities to expand opportunities for funding. Access to these vital resources should not depend on where a school is located, its demographics, etc. a high-quality STEM education should be available to all students.

Building a strong relationship between families, schools, and communities can be crucial for education. Creating partnerships with businesses and organizations in your community can help bring real world experiences into the classroom to help provide students with a purposeful and meaningful STEM education. This will also help expose them to a variety of STEM career paths. To build relationships with families you can create STEM nights, provide at-home projects, or workshops to encourage parents to support their children's creativity and curiosity. Family engagement will also help reinforce that STEM is for everyone and is accessible to everyone. When schools, communities, and families work together, the students will benefit by engaging in a more connected educational experience that will extend beyond the classroom.

At the heart of breaking the barriers within STEM education, creating commitment to equity and inclusion is vital. Districts and schools must actively seek ways to end the bias and systemic inequities that limit students' involvement in underrepresented groups, such as students of color, English language learners, and students with disabilities. Culturally responsive teaching can help STEM content become more relatable and accessible by connecting lessons to students lived experiences. By creating inclusive environments where all learners feel supported and valued, educators can help each child see their potential and use their creativity in STEM.

Importance of Early Exposure to STEM

Early STEM education plays a pivotal role in shaping students' academic pathways, career interests, and experience with STEM fields, making equitable access during childhood essential for long-term success and representation within STEM. Early exposure is critical in shaping students' critical thinking, problem-solving, and curiosity that students will carry into later graders. Research shows that students often develop an interest in STEM fields before age 14. Making these early elementary years a crucial time for them to engage in STEM to spark an interest (Microsoft & Harris Poll, 2016). Having the introduction to STEM concepts through hands-on, age-appropriate activities helps students see themselves as scientists, engineers, etc. rather than seeing math, science, engineering, as being difficult subjects or intimidating. Early experiences with STEM can promote collaboration, creativity, confidence, and persistence, skills that benefit students in all aspects of their life. By giving students these opportunities early on, schools can help broaden access to future pathways in STEM and reduce other gaps related to participation and career paths in STEM.

Final Thoughts

The evidence found is clear; early exposure to STEM strongly influences students' collaboration, creativity, confidence, and future pathways. However, without clear and explicit changes to these barriers, many students will lack these crucial skills. As schools move forward, our focus should be on implementing STEM in an impactful and meaningful way that focuses on STEM being essential and not an extracurricular activity. With commitment, early STEM education can be implemented and will leave a lasting impact on all students.

What is evident is that improving our STEM education in the K-5 setting does not fall on teachers alone. It requires a collaboration of efforts from all stakeholders. When these groups share the common vision of improving instruction to benefit our students, STEM becomes achievable and manageable for teachers, students, and administrators. This commitment reduces the high pressures placed on teachers but will also ensure that students receive consistent, engaging, and meaningful STEM instruction.

These reflections highlight the need and promise of implementing STEM in early education. With proper planning, strategic strategies for support, and a common vision, meaningful STEM instruction in the K-5 setting will foster long term academic growth and build strong future career pathways for students. The barriers are significant, but the impact they have on our students' lives, both now and in the future, makes these efforts as a teacher crucial.

References

American Association of University Women (AAUW). *Solving the Equation: The Variables for Women's Success in Engineering and Computing*. AAUW, 2015, www.aauw.org/app/uploads/2020/03/Solving-the-Equation-report-nsa.pdf.

Banilower, Eric R., et al. *Report of the 2018 NSSME+: Status of Elementary and Secondary Science and Mathematics Education in the United States*. Horizon Research, Inc., 2018, www.horizon-research.com/2018nssme/wp-content/uploads/2020/03/2018-NSSME-Full-Report.pdf.

Breiner, Jonathan M., et al. "What Is STEM? A Discussion About Conceptions of STEM in Education and Partnerships." *School Science and Mathematics*, vol. 112, no. 1, 2012, pp. 3–11. https://doi.org/10.1111/j.1949-8594.2011.00109.x.

Education Trust. *If Not Now, When? The Urgency of Equity in STEM Education*. The Education Trust, 2021, edtrust.org/resource/if-not-now-when-the-urgency-of-equity-in-stem-education/.

Giamellaro, M., Ewing, B. & Siegel, D. Affordances and Constraints to Implementing Project-Based STEM: A Case Study of Systemic School Change. Int J of Sci and Math Educ 23, 849–869 (2025). https://doi.org/10.1007/s10763-024-10487-x

https://www.researchgate.net/publication/389359290_Challenges_in_Preparing_Elementary_Educators_for_STEM_Teaching_Roles

https://citejournal.org/volume-20/issue-4-20/science/teacher-self-efficacy-in-a-rural-k-5-setting-quantitative-research-on-the-influence-of-engineering-professional-development/

Margot, K.C., Kettler, T. Teachers' perception of STEM integration and education: a systematic literature review. *IJ STEM Ed* 6, 2 (2019). https://doi.org/10.1186/s40594-018-0151-2

Microsoft Corporation & Harris Poll. *STEM Perceptions: Student & Parent Study*. Microsoft, 2016,https://news.microsoft.com/download/presskits/STEM/docs/STEMPerceptionsReport.pdf.

Microsoft & Harris Poll. (2016). *STEM perceptions: Student & parent study*. Microsoft Corporation.

National Academies of Sciences, Engineering, and Medicine. 2025. Scaling and Sustaining Pre-K-12 STEM Education Innovations: Systemic Challenges, Systemic Responses. Washington, DC: The National Academies Press

National Science Board. *The State of U.S. Science and Engineering 2022*. National Science Foundation, 2022, www.nsf.gov/statistics/state-of-us-science-and-engineering.

U.S. Bureau of Labor Statistics. “STEM Occupations: Past, Present, and Future.” *Occupational Outlook Quarterly*, 2023. https://www.bls.gov/oes/current/oes_stem.htm.

White, David W. "What is STEM education and why is it important." *Florida Association of Teacher Educators Journal*1.14 (2014): 1-9.

Xie, Yu, Michael Fang, and Kimberlee Shauman. "STEM education." *Annual review of sociology* 41.1 (2015): 331-357.