Stimulating the Interest of Young Learners in Physics through Storytelling and STEM Activities

Emmanuel Babalola
Purdue University

Wonjin Yu
Purdue University

Hillary Ongoyo Omoze
Purdue University

See next page for additional authors

Follow this and additional works at: https://docs.lib.purdue.edu/pjsl

Part of the Curriculum and Instruction Commons

Recommended Citation
Babalola, Emmanuel; Yu, Wonjin; Omoze, Hillary Ongoyo; Saka, Zainab; Ojike, Favour; Adedeji, Iyanu; and Yue, Zhu (2023) "Stimulating the Interest of Young Learners in Physics through Storytelling and STEM Activities," Purdue Journal of Service-Learning and International Engagement: Vol. 10 : Iss. 1, Article 6. DOI: https://doi.org/10.5703/1288284317690
Available at: https://docs.lib.purdue.edu/pjsl/vol10/iss1/6

This document has been made available through Purdue e-Pubs, a service of the Purdue University Libraries. Please contact epubs@purdue.edu for additional information.

This is an Open Access journal. This means that it uses a funding model that does not charge readers or their institutions for access. Readers may freely read, download, copy, distribute, print, search, or link to the full texts of articles. This journal is covered under the CC BY-NC-ND license.
Stimulating the Interest of Young Learners in Physics through Storytelling and STEM Activities

Cover Page Footnote
We would like to sincerely express our gratitude to our project and writing mentor, Dr. Shamila Janakiraman, for her unwavering support and encouragement throughout the duration of the project. Her mentorship and guidance have been invaluable to us. We also extend our appreciation to the entire staff and management of Imagination Station. Special thanks to the board president Sujatha Ramani, the office manager Dee Bishop, and Georgeanna Hardesty for partnering with us to make a positive impact on the young learners. Also, thank you to the wonderful volunteers (Purdue students) at Imagination Station for offering their support to make the project a success. Finally, this would not have been possible without the financial support of the Purdue Service-Learning Community Service/Service-Learning Student Grant Program and the Office of Engagement toward the execution of the PFP. We are appreciative of their support.

Authors
Emmanuel Babalola, Wonjin Yu, Hillary Ongoyo Omoze, Zainab Saka, Favour Ojike, Iyanu Adedeji, and Zhu Yue

This reflective essay is available in Purdue Journal of Service-Learning and International Engagement:
https://docs.lib.purdue.edu/pjsl/vol10/iss1/6
STIMULATING THE INTEREST OF YOUNG LEARNERS IN PHYSICS THROUGH STORYTELLING AND STEM ACTIVITIES

Emmanuel Babalola (Learning, Design, and Technology); Wonjin Yu (Learning, Design, and Technology); Hillary Ongoyo Omoze (Mathematics Education); Zainab Saka (Civil Engineering); Favour Ojike (Agricultural Sciences Education and Communication); Iyanu Adedeji (Interdisciplinary Life Science Program); Zhu Yue (Learning, Design and Technology)

STUDENT AUTHOR BIO SKETCHES

Emmanuel Babalola is a Ross Fellow and a PhD student in learning, design, and technology at Purdue University. Emmanuel is a graduate teaching assistant for the “Introduction to Educational Technology” course. His research is focused on how motivational design can bridge learning transfer gaps in the K–12 education space and how that understanding can be integrated into lifelong professional development programs for preservice physics teachers. Emmanuel initiated and coordinated the Physics is Fun Project, through which he inspires and motivates learners of all ages to discover and appreciate the fun and fascinating aspects of physics.

Wonjin Yu is currently a PhD student in learning, design, and technology at Purdue University. He is also the recipient of the David Ross Fellowship at Purdue. Wonjin majored in elementary computer education for his master’s degree, and he has an interest in computer science education for all and various emerging technologies for education including artificial intelligence education. In 2023, he engaged in the Physics is Fun Project as a volunteer and explored community impact from the experience. Wonjin jointly developed the community impact section of this essay.

Hillary Ongoyo Omoze is currently a PhD student in curriculum and instruction (mathematics education) at Purdue University. His research interests are in mathematics classroom discourse, what makes it productive, and what makes it different from place to place. Hillary loves reflective dialogue and appreciates diversity and experiences that affect our current and forming identities. In 2022, he engaged in the Physics is Fun Project as a volunteer. He has had the fun of working with and listening to young children as they explore the tech world. Hillary jointly developed the community impact and conclusion sections of this essay.

Zainab Saka is a second-year master’s student in the Department of Civil Engineering at Purdue University specializing in transportation. She is a Ross Fellow working as a graduate research assistant at the Center of Connected and Automated Transportation, where she is engaged in research focused on determining the optimal placement of LiDAR sensors on autonomous vehicles. Zainab is committed to using her skills and knowledge toward community development and engagement. She volunteered as a facilitator for the Physics is Fun Project. Zainab jointly developed the description section of this essay.
Favour Ojike is a master’s student in agricultural sciences education and communication at Purdue University. She is a graduate research assistant and teaching assistant for 4-H Purdue Extension and the Office of Multicultural Programs. Favour’s research interest focuses on ethical standards that reduce counterproductive behaviors in agricultural extension systems in developing countries. Her career goal is to become an agricultural development/extension specialist. As a volunteer, Favour supports the Physics is Fun Project as a facilitator and a member of the planning team. She jointly developed the description section of this essay.

Iyanu Adedeji is a PhD student and Lynn Fellow in the Interdisciplinary Life Science Program at Purdue University. Her research interest focuses on understanding how plants respond to changes in environmental factors and the development of resilient crop genotypes that maintain yield stability. Iyanu aspires to continue her education after completing her PhD, with the goal of obtaining a postdoctoral position. In 2023, she offered her services as a volunteer mentor for the Physics is Fun Project. Iyanu jointly developed the conclusion section of this essay.

ABSTRACT

The Physics is Fun Project is an initiative funded by Purdue’s Office of Engagement and aims to promote an interest in physics among young learners aged 5 to 12. The project’s unique approach blends instructional design and motivational design to create an engaging and relevant learning experience. Development of the project was guided by the analyze, design, develop, implement, and evaluate (ADDIE) framework and Keller’s attention, relevance, confidence, and satisfaction (ARCS) theory and utilized storytelling and hands-on learning strategies to bring physics to life through the story of a young physics enthusiast who is passionate about building a dream car. Basic physics concepts such as force, motion, and energy were presented using age-appropriate language and large infographics with relatable examples. Learners each received a STEM packet to construct their own dream car, therefore providing an authentic learning experience as they assembled their own car with the physics concepts. The first outreach was held in collaboration with Imagination Station in Lafayette and reached over 30 young physics inquirers with minimal scaffolding to support their learning.

INTRODUCTION

Physics is a crucial subject in science learning that has a wide range of applications in various life endeavors (Msoka et al., 2015). However, there has been a consistent decline in K–12 learners’ enrollment in physics, which is a worrisome trend (Msoka et al., 2015; Witteveen & Attewell, 2020). Motivation-related factors have been opined to be one of the leading reasons for this decline. Motivation-related factors include learners not seeing the relevance of what they are learning to their daily lives (Msoka et al., 2015; Ng & Nguyen, 2006), learners finding physics boring and unengaging due to the lack of engaging teaching methods and strategies (Msoka et al., 2015), and poor attitude toward physics because of the belief that physics is the cause of evil in the world (Ali, 2016; Bayar & Kerns, 2015).

To address this issue, the Physics is Fun Project (PFP) was introduced as a community outreach and engagement program (Furtak & Penuel, 2019). The PFP aims to reach out to young learners ages 5 to 12 and help them spark an early interest and curiosity in physics using STEM activities and a storytelling approach (Furtak & Penuel, 2019). The project focuses on making physics relatable and relevant to learners’ daily lives and helping young physics inquirers see the practical applications of physics. The PFP is consistent with the fundamental goals of Project 2061, coordinated by the American Association for the Advancement of Science, and the Next Generation Science Standards (Furtak & Penuel, 2019), where emphasis is placed on the effective connection of “mind-on” skills and “hands-on” skills.

STEM activities, such as building a dream toy car, have been proven to be effective in developing learners’ career interests in STEM and their science process skills (Hığde & Aktaṣ, 2022). Figures 1 and 2 show two young learners screwing the bolts of their toy car during the PFP program. Furthermore, the storytelling approach employed by the PFP has been identified as an effective way to introduce basic concepts to young learners (Casey et al., 2004). This approach helps learners build a sense of community and bonding with adults, supports literacy development, and enhances their imagination and creative abilities (Casey et al., 2004).

Although the decline in K–12 learners’ enrollment in physics is a worrisome trend, initiatives such as the PFP can address this issue by making physics fun, engaging, and relatable to learners’ daily lives. The PFP integrates STEM activities and a storytelling approach so that
Stimulating the Interest of Young Learners in Physics Through Storytelling and STEM Activities

Imagination Station is a nonprofit organization in Lafayette, Indiana, founded in 1999 by the Association for Science, Space, Engineering, and Technology. The facility aims to educate children and adults about science, space, and technology through interactive displays and activities. The Indiana Gas Corporation donated the building that houses Imagination Station, and it was dedicated on March 5, 1999, by astronaut Mark Brown. Although the exhibits and facilities have changed over the years, the organization’s fundamental purpose of fostering scientific curiosity has remained consistent. The PFP is just one of the numerous initiatives that Imagination Station offers, providing hands-on learning experiences for children and families in their community.

Imagination Station relies on community support and offers various volunteering opportunities, such as creating new programs and events, supervising parties and field trips, grant writing and fundraising, creating exhibits, and developing community partnerships.

In addition, as a member of the Association of Science and Technology Centers, Imagination Station offers its members free admission to all other participating centers, providing a valuable opportunity for members to explore a variety of science and technology exhibits throughout the country. For over two decades, Imagination Station has served families in the Lafayette and West Lafayette communities, offering various services including field trips, educational/fun activities, birthday parties, exhibitions, camps, and gift shopping.

Imagination Station mainly focuses on providing hands-on STEM learning activities for children and teens. With its commitment to education and community engagement, the facility remains an essential resource for the Lafayette area. Imagination Station serves a diverse community of children from different races and countries. The target audience for its programs are primarily preschoolers to sixth graders, a group whose interest in STEM can be sparked through a fun and playful approach. Although the primary clients are children under age 12, Imagination Station also serves older children and adults. For instance, the PFP served up to 50 people within the Greater Lafayette community, including 30 young learners and their parents. Imagination Station provides educational programs tailored to specific age groups. These programs cover a wide range of topics, including chemistry, physics, mechanics, and sound.

The organization seeks to provide a strong foundation in scientific principles for children while also engaging adults. To continue fulfilling its mission, Imagination Station may need to expand its offerings with more experiential learning opportunities that have practical applications in order to stimulate children’s interest in STEM. Ultimately, Imagination Station’s goal is to provide support for the educational and intellectual growth of young learners in the community. The organization is led by a board of directors and various hosts and volunteers who work together to develop programs.

The first author’s passion for physics and inspiring young learners led to the idea for the PFP. Dr. Shamila Janakiraman, the project’s mentor, recommended the community partner. After visiting Imagination Station, the project was deemed appropriate for the target audience. The community partner provided space and resources, and volunteers brought the project to life. Figure 3 shows the flyer created for the PFP program by our community partner. Successful collaboration between everyone involved ensured the project’s success.

Imagination Station offers project and service opportunities for Lafayette community students, including volunteering. By volunteering, students can gain valuable experience in event planning, program design and
Poraxy STEM kits were purchased from Amazon. To facilitate the project, a team of five volunteers was initially formed who communicated through virtual meetings on Microsoft Teams. Each team member had a one-on-one physical session with the group leader to learn how to assemble the toy car and prepare for facilitating the group activity as shown in Figure 4.

The project planning focused on hands-on learning, incorporating storytelling and demonstrations to achieve desired results. The storytelling approach featured a young child who pondered the movement of cars and sought to inquire from her physicist uncle. The child was introduced to three friends, “Mr. Force,” “Mrs. Motion,” and “Aunty Energy,” who explained the connections between physics concepts and the movement of cars. All team members played a character and served as implementation, and community outreach while making a positive impact in their community. Working alongside staff, students can create new STEM-related learning activities, such as interactive games and team-building exercises, tailored to the interests and needs of Imagination Station’s target audience.

The PFP was designed with three criteria in mind: engagement, immersion, and hands-on learning. Each aspect of the program was created using the analyze, design, develop, implement, and evaluate (ADDIE) framework and Keller’s attention, relevance, confidence, and satisfaction (ARCS) theory (Spector & Park, 2017). This approach emphasizes learning by doing and doing to learn, enabling young learners to gain a deeper understanding of the subject area. Furthermore, after evaluating several demonstration kits, we choose the Poraxy STEM kit because it is age-appropriate and can be assembled with minimal facilitation.
facilitators when it was time to apply the learnings to assembling a toy car. As shown in Figure 5, three infographics were designed for the project tailored to the age and cultural diversity of the target audience. The project was financed through an approved grant application to the Purdue Community Engagement and Service-Learning Grant. The PFP is similar to other projects at Imagination Station, such as bike mechanics, chemistry, and platelet demonstrations. Each program has a unique methodology based on its scope and organizers. This project serves as an example of a program that could be offered again, providing a unique experience for students interested in physics or education.

COMMUNITY IMPACT

We evaluated this program using self-reported reflective analysis. This approach combines observations and feedback from our community partner and our volunteers to highlight the outcomes of the PFP and the implications for STEM education and career pathways. Based on the feedback we received from the board president and the office manager, we deduced three major themes: increased stimulation of interest and engagement, increased membership growth and enhanced attendance, and skills development and collaborative learning.

Furthermore, our volunteers also reported on their experiences in the PFP with an emphasis on the children’s attention, curiosity, involvement, and knowledge of the activities in order to examine the outcomes of the program. Figure 6 shows one of our volunteers providing scaffolded assistance to one of the learners. Following the frequencies of the eight large domain codes, we then collapsed them into five main codes for the volunteers’ reflections. These seven large domain codes were engagement, challenging barriers, support and collaboration, curiosity, interest, instructional strategies, and understanding. They significantly assisted us in visualizing and assessing the program.

Community Partner’s Reflection

According to the reflection from the office manager and the feedback from the board president, they observed
STIMULATING THE INTEREST OF YOUNG LEARNERS IN PHYSICS THROUGH STORYTELLING AND STEM ACTIVITIES

Volunteers’ Reflections

Young students participated enthusiastically in the activity alongside their parents and volunteers during the PFP. A volunteer gave the following example: “I started by showing the children a moving toy car and asking them if they knew that they could make that happen. The children’s eagerness to produce a moving toy car intrigued them to learn and walk through the procedure to obtain the ultimate outcome.” This claim proved that young students could participate in the PFP with such elevated levels of interest and curiosity.

A second volunteer added, “Some of the things that we did to keep them interested include the friendliness, the storytelling, and acting out the roles of Mr. Force, Mrs. Motion, and Aunty Energy.” This response from the volunteer demonstrated the strategy’s impact on improving learners’ conceptual knowledge, beyond just the enjoyable component. They demonstrate the beneficial effects of piquing learners’ interest and efficiently tying it to their comprehension of basic physics concepts.

Collaboration

Our partnership with the Imagination Station children’s science center and the parents of the young students resulted in reciprocal partnerships and support for us. The fact that our community partner at Imagination Station invited us back to repeat the same project a second time with a different audience shows how well...
the program’s goal of piquing young children’s interest in physics was achieved. That shows how committed the community partner is to seeing us succeed and move on.

Our partner made a commitment to helping the PFP by creating sufficient publicity online and by developing fliers. Also, our partner was willing to adjust and let us reorganize the room for the PFP every time. With this assistance, we reorganized the space with the students in mind.

We were also grateful for the support of most of the participants’ families. “This experience didn’t simply apply to the children, but their parents,” observed one of our volunteers. Another volunteer further stated that “several of the children I worked with had their parents stand by them, support them, and their parents did express gratitude after the activity.” These volunteers’ responses showed how well our PFP has developed as a unit with help from both parents and our community partner. Figure 7 shows one of the parents actively involved and cheering on a young learner, while Figure 8 shows the participation of one of the volunteering students working at Imagination Station.

**Long-Term Impact on STEM Education and Careers**

The impact of the PFP has far-reaching implications. By focusing on promoting STEM education, particularly in physics, from an early age, we aim to increase

![Figure 7. Active Participation from Parents (STEM Activity)](image1)

![Figure 8. Active Engagement and Participation from Adults (STEM Activity)](image2)
enrollment in STEM majors and inspire future STEM career paths. Additionally, the PFP aligns with the American Physical Society’s Forum of Public Engagement commitment to reinforce public outreach and engagement in physics.

We also presented the lessons we learned from the PFP (as shown in Figure 9) alongside other presenters and what physics teachers can apply from these lessons in the recently concluded spring 2023 meeting of the Indiana Section of the American Association of Physics Teachers at Indiana University Kokomo. Furthermore, we also presented the PFP lessons and impact in a poster presentation at the Purdue Engagement and Service-Learning Summit, as shown in Figure 10.

CHALLENGES AND BARRIERS

The project’s activities have proceeded successfully for the most part; however, we did run into two minor challenges. The first one involved an occurrence for which we were unprepared but nevertheless faced. One of the children celebrated her birthday during our first PFP event. We had to change the intended location. We also thought that this might take the young students’ focus away from the activity. We therefore had to discuss how to adjust and change our plans considering the situation. We also discussed with our community partner and implemented our adaptation plans.

Regarding the second challenge, we had a group of very young students, ranging in age from three to five, who were enthusiastic but had short attention spans. Other young children enjoying fun with the numerous technical displays readily diverted them. We employed a variety of instructional techniques to keep their attention. One of our volunteers, for instance, wrote, “Then I explained the notion of physics to them using familiar metaphoric figures, such as Mr. Force.” In this way, we took into account the environment and cognitive growth of the young learners. In conclusion, the majority of participants demonstrated a high level of interest in the PFP activity and had a positive and rewarding experience.
STUDENT AUTHOR IMPACT

In this section, volunteers reflect on the impact of the program and its relevance to their professional development and career.

Theory in Practice

**Emmanuel:** My participation in the PFP event provided a unique and unparalleled opportunity for me to apply instructional design principles and collaborate with community partners to create engaging and impactful instruction for young learners. As a graduate student in the Department of Learning Design and Technology, I integrated the ADDIE framework and Keller’s ARCS theory into the project, which resulted in the active involvement of over 50 young physics enthusiasts. The experience of bridging the gap between theory and practice in this project is directly relevant to my research interest, which explores motivational design as a viable solution for knowledge transfer gaps among preservice physics teachers.

Furthermore, my involvement in a diverse multicultural group of volunteers significantly enhanced my intercultural competencies and group managerial skills. The PFP has ignited a passion within me to give back to the community through volunteering and the pursuit of my lifelong goal of simplifying K–12 physics through technology-enhanced active learning and learning motivation.

**The “T” in STEM**

**Wonjin:** This spring of 2023, the PFP has been one of the opportunities to ponder how my career and research interests can be enhanced. Since the PFP aimed to serve fun physics to young learners with a pedagogical approach and STEM, I was able to connect this project with my career aspect, especially technology, the “T” in STEM. In terms of the technology, I could connect it with one of my personal career and research interests: computational thinking for all.

Computational thinking is considered one of the important literacies for all students that they can learn and enhance to give them opportunities preparing their future (Wing, 2006). Computational thinking has been covered through various disciplines, not only the computer science discipline. In the PFP activity, young learners met with the parts for the toy cars in the beginning and started to think about the problem-solving process as problem decomposition.

Our volunteers’ guidance with instructional strategies helped young learners ponder their own problem-solving process and solve their problem step by step and in effective ways. In this sense, the PFP has shown the possibility of implementing computational thinking through the STEM path. I would appreciate having this opportunity to develop and explore further possibilities about my research interest and career through the PFP.

**Engaging Young Learners in STEM Education: Insights from the PFP**

**Zainab:** The PFP at Imagination Station was an invaluable experience for me, as it provided me with insightful knowledge that demonstrated the effectiveness of introducing STEM concepts in a fun and engaging way to young learners. The project showed me that by creating an enjoyable learning environment, we can catch the interest of young learners and keep them actively participating in the learning process.

As an engineering student specializing in transportation, I understand the importance of fostering interest in STEM fields, and the project proved that this is possible to achieve. While the project was centered on physics, the techniques used can be applied to other STEM subjects and fields, including transportation. This aspect was particularly relevant to me, as it helped me understand how I can make engineering concepts more interesting for young learners.

Additionally, working with a multidisciplinary team on the project was an excellent opportunity for me to appreciate the importance of collaboration and teamwork in achieving a common goal. The project demonstrated that different perspectives and expertise can contribute to the success of a project.

**The “M” in STEM**

**Hillary:** My aim is to understand how integrated STEM can serve as a culturally and geospatially responsive pedagogical approach to teaching and learning STEM disciplines. I believe that teaching and learning of STEM disciplines are situated in space and place contexts where students’ prior knowledge and in-school and out-of-school experiences act as the building blocks as they move forward in the STEM path.

The 2018 National Assessment of Educational Progress report (as cited in White et al., 2021) indicated the underrepresentation of students of color in the STEM field, and the observations that most students of color
withdraw from pursuing STEM courses by the time they finish middle school (Nord et al., 2011) spurs my interest in exploring the effect of space and place on student learning and how to ensure equitable STEM teaching and learning. The PFP is one such activity that could potentially create and sustain students’ interest in the STEM path from an early age. The storytelling and nonformal learning approach simplified complex physics concepts for the children, ages 5 to 12, as they assembled their toy cars and displayed fluency in the application of basic physics principles.

The project has motivated and impacted the lenses I use to position the “M” (mathematics) in integrated STEM lessons. This experience adds to my struggles in conceptualizing social constructivism as a learning theory and situating student learning in space and place contexts.

Expanding Horizons: Developing Design Competencies through Interdisciplinary Projects

**Favour:** The PFP was my first learning engagement with children in the United States, and even though the subject matter (physics) is not one within my career field, I appreciated the process and experience. In extension, one of the skills I am learning is effective program development, which involves working with various audiences, young and old, male and female, agriculture and nonagriculture audience, educated and uneducated, traditional and modern, and so on.

The PFP, although not extensive, added to my understanding of working on projects with a team of people with a wide range of skills and expertise. I do not possess skills in physics but worked with subject matter specialists and also contributed my skills to the project implementation. Before PFP, I never thought of working on projects beyond the field of agriculture. The PFP is the first, and I am pleased to have worked on the project. Regarding attention to age, I have learned in my classes that understanding your target audience is very crucial because it will inform how the program is designed, planned, and executed, specifically learning activities and techniques.

Putting knowledge into practice, the PFP adopted a storytelling and demonstration approach that was suitable for the target audience. Moving forward, the PFP experience will contribute immensely to my role as a research assistant with the Purdue Extension 4-H Youth Development and the various places to which my career interests in extension will take me.

**CONCLUSION**

Making physics accessible, engaging, and relatable to young learners’ daily lives has been the main goal of the PFP. We achieved this goal by using storytelling and hands-on STEM activities, thus connecting minds-on and hands-on learning. This made it possible for us to properly explain basic physics ideas to the young learners. We encourage all students—graduates and undergrads—to get involved in volunteer opportunities such as these because they benefit both the volunteers and the community by fostering community connections and involvement, igniting an interest in STEM fields and inspiring future generations of scientists and engineers. By adapting and changing their teaching methods to the requirements of young children at different grade levels, clarifying complex topics, outlining key concepts in plain language, and offering guidance and criticism, the project also improves the volunteers’ communication and leadership skills.

We think that encouraging STEM-based courses through pre-K and post-K will be greatly aided by designing many such centers based on the Imagination Station center and encouraging STEM-based enjoyable activities such as the PFP. Some of the volunteer opportunities available at Imagination Station include organizing and taking part in PFP-like programs and events, collaborating with community-based organizations that host these programs and events, supervising birthday parties and field trips (possibly leading demonstrations and activities), and grant writing and fundraising. By collaborating with local communities, volunteers can use their contacts to establish new partnership relationships for the science center and to encourage the creation of STEM-related items for exhibitions.

**REFERENCES**


We would like to sincerely express our gratitude to our project and writing mentor, Dr. Shamila Janakiraman, for her unwavering support and encouragement throughout the duration of the project. Her mentorship and guidance have been invaluable to us.

We also extend our appreciation to the entire staff and management of Imagination Station. Special thanks to the board president Sujatha Ramani, the office manager Dee Bishop, and Georgeanna Hardesty for partnering with us to make a positive impact on the young learners. Also, thank you to the wonderful volunteers (Purdue students) at Imagination Station for offering their support to make the project a success.

Finally, this would not have been possible without the financial support of the Purdue Service-Learning Community Service/Service-Learning Student Grant Program and the Office of Engagement toward the execution of the PFP. We are appreciative of their support.