Paper ID #42898

Board 274: Exploring Problem-Solving Experiences in Autism-Inclusion Schools Using Photovoice: A Collaborative Data Collection Process

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I am pursuing my doctoral studies at NYU Steinhardt School of Culture, Education, and Human Development in the Department of Occupational Therapy. I work with Vice Dean Kristie Patten on a National Science Foundation (NSF) project titled "Developing Abilities and Knowledge for Careers in Design and Engineering for Students on the Autism Spectrum by Scaling Up Making Experiences." Through this project, I intend to explore the impact of interest-driven and strength-based engineering activities on autistic students' learning and social development. I am particularly interested in understanding how neurodiverse adolescents problem-solve independently when engaged in interest-driven tasks. As I firmly believe research must be done with participants and community members, I incorporate participatory approaches to seeking answers to questions that are meaningful to the autistic community.

Before starting my journey at NYU, I completed graduate studies in Occupational Therapy in the UK and I completed my undergraduate studies in Occupational Therapy at the Maharashtra University of Health Sciences in India. I have experience working with a diverse population of children with developmental disabilities in Mumbai and Edinburgh. I have also contributed to various national and international research projects, the most notable being the Global Co-operation on Assistive Technology with the World Health Organization through my nomination with the World Federation of Occupational Therapists in 2019.

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Dr. Ariana Riccio Arista leads research to mitigate the gap in services that autistic individuals experience in postsecondary settings. Her studies seek to improve curricula, transition supports, and pre-employment campus programming for autistic youth by using participatory research design, which employs the autistic community as co-creators of research products.

Arista is the principal investigator (PI) of the National Science Foundation-funded project Engaging Autistic STEM Undergraduates in Creating Supportive Learning Environments, and she is co-PI on Making Mentors: Enhancing Access to STEM Careers for Autistic Youth through Mentorship Programs in Makerspaces. She is collaborating on the NASA-funded initiative NASA's Neurodiversity Network, which is working to create pathways to NASA participation and STEM careers for neurodiverse learners, particularly those who identify as autistic.

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Kristie Patten, PhD, OT/L, FAOTA, is Counselor to the President at NYU and a professor at NYU Steinhardt in the Department of Occupational Therapy. Dr. Patten's research focuses on utilizing a strength-based paradigm, in partnership with stakeholders, to understand the impact of our biases and practices on quality of life and well being with a focus on interventions in inclusive settings. Dr. Patten has received over $20 million dollars in external funding for her research and programs. Dr. Patten is the Principal Investigator of the NYU Steinhardt's ASD Nest Program, an inclusive program for children and adolescents with autism in the New York City Department of Education, the largest inclusion program in the country, grounded in strength based practices. She is Co-PI of an NSF grant entitled, "Making Mentors: Enhancing Access to STEM Careers for Autistic Youth through Mentorship Programs in Makerspaces" which is an expansion of an earlier NSF grants entitled, "Developing Abilities and Knowledge for Careers in Design and Engineering for Students on the Autism Spectrum by Scaling Up Making Experiences" "IDEAS: Inventing, Designing and Engineering on the Autism Spectrum". These projects leverage strengths and interests of 5th through 12th grade students on the spectrum to develop

social competence and potential career pathways as well as train autistic college students to mentor autistic high school students. Dr. Patten has published and presented nationally and internationally on topics related to examining the efficacy of public school interventions and viewing autism from a strength-based or abilities-based model.

Exploring Problem-solving Experiences in Autism-inclusion Schools Using Photovoice: A Collaborative Data Collection Process

Abstract

Many K-12 educational programs have recognized the strengths of developing programs that foster critical thinking, problem-solving, and analytical reasoning skills using strategies like the engineering design process (EDP) [1], [2]. By engaging in these programs, students learn to apply conceptual knowledge from science and related subjects, including engineering, to solve open-ended and ill-defined problems creatively [3], [4]. These skills can also prepare autistic students to succeed in real-world contexts [5]. We created engineering maker clubs in public schools across New York City to provide inclusive spaces for elementary, middle, and high school students. We aimed to enhance co-designing and develop technological knowledge and engineering skills in autistic and non-autistic students. These clubs are safe, nurturing, and accessible to all students. These clubs were centered on student interests and used project-based learning [6]. In this study, we used Photovoice to explore students' experiences using EDP to solve design problems. Students collected photographs as they solved design-related issues [7]. This paper showcases their perspectives on problem-solving (PS) using EDP by analyzing the photographs collaboratively. We present the preliminary results of our thematic analysis that captures these students' crucial voices.

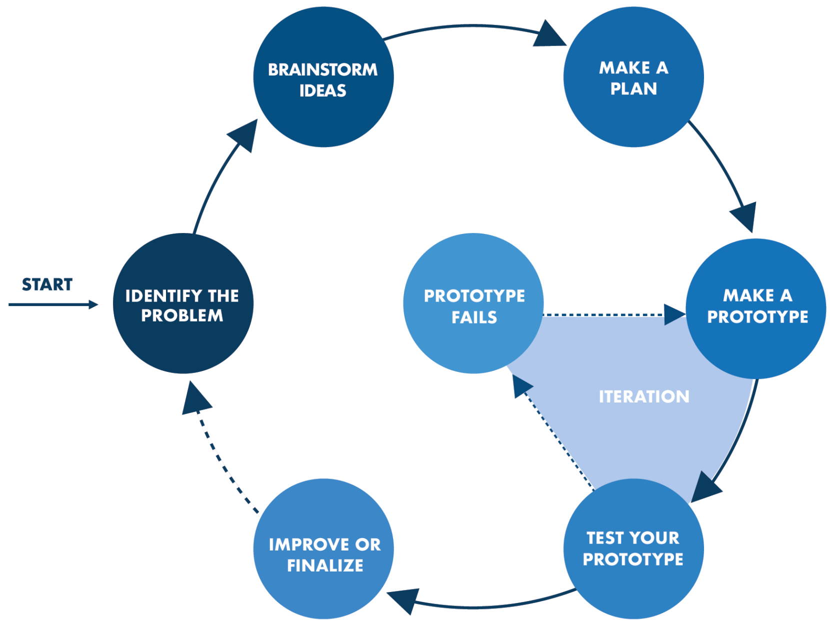
Introduction

Inclusive education systems are gaining increased visibility as they are expected to develop innovative strategies to integrate autistic students authentically into mainstream learning contexts [8]. Autistic students demonstrate notable differences in executive functions and PS skills, amongst other characteristics [9], [10], which are conventionally considered as deficits needing remediation [11]. Despite increased recognition of these students' skills and abilities, they are still underrepresented in mainstream education due to societal and structural attitudes that focus on highlighting and remediating their deficits [3]. In order to equip autistic students to succeed in schools, Cahill & Bazik [12] and Bolton & Plattner [13] advocate for creating programs to foster and expand cognitive, developmental, and emotional attributes for building PS and life skills.

However, existing programs that focus on developing PS skills are criticized for their lack of structural flexibility to accommodate the heterogeneity of characteristics demonstrated by the autistic community [14]. Furthermore, many conventional interventions intend to remediate deficits in PS by developing interventions that only fulfill goals decided by the researcher/practitioners and which are based on students’ skill deficits without considering their motivations and interests [15]. Engineering education has the potential of imparting practical PS skills and converting abstract and conceptual knowledge by facilitating the application of various science, math, and technological concepts to creatively address open-ended, complex, multi-faceted, and ill-defined problems [3], [4]. K-12 educational institutions can integrate engineering concepts, design thinking, and PS strategies into classrooms and informal learning spaces [1], [2]. By combining engineering education with a culture of maker spaces, researchers can create supportive environments where individuals or groups create digital or tangible objects and actively participate in the design process [16]. The agency provided by these spaces can empower students to develop unique and innovative products or solutions in a self-directed manner [16]. These programs adopt the EDP to teach PS skills to foster STEM identities and interest in STEM careers by teaching students to apply engineering concepts [17], [18]. Many autistic students also have demonstrated interest in engineering due to their familiarity with pattern recognition, meticulous attention to detail, and intense focus on tasks aligned with personal interests [19].

The EDP (Fig. 1) is a seven-step cyclical PS process that engages students in problem scoping, resource mapping, locating, brainstorming ideas to find possible solutions, prototype development, testing, and revising to meet the student's goals [17], [18]. The EDP is unique because it normalizes redoing, improvising, and making mistakes by encouraging students to iterate possible solutions. Moreover, the EDP has the potential to teach students pattern recognition, association, critical analysis, and flexible thinking skills, along with developing communication and collaboration [20]. Another notable characteristic of the EDP is that it can accommodate a variety of communication styles (e.g., spoken language, written communication, use of pictures) to share ideas, and this versatility is crucial when using the EDP with autistic students who demonstrate a diversity of communication strategies [20]. Learning these skills can prepare autistic adolescents for productive post-secondary education or employment opportunities by equipping them with the necessary skills to succeed in these real-world contexts [2], [3].

Fig 1. The Engineering Design Process (EDP cycle)



To develop a program that fosters these skills, we designed inclusive engineering maker clubs across four years (2019-23) with experts from engineering, maker education, autism, and occupational therapy. Our project, entitled "*Developing Abilities and Knowledge for Careers in Design and Engineering for Students on the Autism Spectrum by Scaling Up Making Experiences,*" is in its seventh year and is provided in New York City public elementary, middle, and high schools. This program provides opportunities for co-designing, learning, technological knowledge, and developing engineering skills. It also provided accessible, safe, and nurturing spaces for autistic and non-autistic students by immersing them in interest-driven making and project-based learning [21]. Research from this program has demonstrated improved student engagement and increased interest in engineering, making, and understanding the value of STEM [6], [21]. Students also showed increased knowledge of the EDP as they developed PS and other cognitive skills [20], [22], [23]. In this study, we intend to understand students' PS experiences in maker clubs using a collaborative data collection approach.

Methods

We incorporated participatory qualitative research approaches, namely Photovoice, to understand students' experiences of independent PS as they engaged in maker club projects. Photovoice is a qualitative research approach that involves active participant collaboration, empowering individuals to share the research process by capturing photos of their experiences [7]. This approach allows participants to convey what is important to them within the research framework. During the data collection phase, participants capture photos, share them with the research team, and later engage in an interview to unpack the meaning behind the images. This approach distinguishes itself from traditional methods, where researchers focus only on verbal data collected during interviews. With Photovoice, participants curate and contribute their own photos, a foundation for photo-elicitation interviews [24].

Social Relevance

To ensure that the research questions were socially relevant and meaningful, we shared them with a group of autistic researchers, and their responses were recorded through a voting session [25]. Experts also had an opportunity to discuss their perspectives comprehensively by sharing their thoughts. All the experts rated the study with "love it" or "like it" responses and then elaborated with detailed explanations and feedback. Once the questions were workshopped here, the feedback was incorporated to revise the research and interview questions accordingly [25]. To ensure students can be proficient in using the cameras, we engaged in a pilot year with one school where teachers introduced the cameras and encouraged students to take photos, develop them, and stick them in their journals. We learned that students could quickly engage with the instant cameras, take photos, develop them by exposing them to light, and solve logistical issues like reloading film and changing batteries. However, we could not collect data in person during this year due to COVID-19 restrictions.

Participants

Fourteen adolescents (ages 10-13 years) from two public middle schools in New York City participated, on average, in the Photovoice research for around 8.5 weeks. Sessions were weekly and ran anytime between seventeen minutes to one hour. Each school had one teacher running the session, with students working independently on most of their projects. Both teachers would introduce a topic, demonstrate or discuss the project, brainstorm with the students, and then allow them to decide, choose, and pursue their unique projects. One school conducted the maker clubs in the morning before school for ~45 -50 minutes once a week, and the other school held maker clubs after school twice a week for 90 minutes. Participation in the club sessions was voluntary.

Photovoice process

In the initial few weeks, students practiced taking photos using Polaroid cameras and had no specific instruction relating to data collection. They learned about the cameras, the film, the process of loading and unloading the cameras, and the process of taking and developing photographs. However, after the fifth week, students were encouraged to capture photos of their projects, successes (e.g., completing the project), failures, mistakes, or external issues resulting in non-completion. We also informed the students that they would be collecting "data" for a research study so they could understand their role and position as research partners. Students then collected photos of their final projects, where they conceptualized, developed, and iterated ideas. We did not set a restriction on the number of photographs that students could capture during this process.

Data collection

The purpose of using the Photovoice process is to democratize data collection and ensure that student voices are heard. The students collected data that was meaningful to them as they created their final projects using the instant Polaroid cameras. Students collected an average of 5-8 pictures at different stages of the design process. Then, they participated in a photo-elicitation interview where they answered questions about the collected photos with the research team. The researchers were mindful of including only photos students perceived as meaningful and essential to their PS journeys. When students decided not to share their photographs or had logistical challenges that impeded them from producing the photos (e.g., left them at home, felt the photos were not of good clarity), then we either took a photo of their project or conducted a semi-structured interview asking them about the project. We also interviewed the two teachers who ran maker clubs in each school to understand the impact of using Photovoice from their perspective.

Data analysis

Data was analyzed by partnering with students as they presented their photographs using the photoelicitation approach. The interviews were then coded thematically using Clarke and Braun's [26] thematic analysis. We immersed ourselves actively and deeply in the data to develop active and inductive codes and themes. As this project is ongoing, we intend to collaborate with our middle school participants to analyze the collected data and create rich and comprehensive descriptions.

Results

The students presented 71 photographs that were used in this analysis. However, a total of 160 photographs were collected from both schools. These included photographs that needed more clarity (N=35) and those that students collected from and of their friends and peers, which were not included in this analysis (N=54). The three themes from this preliminary thematic analysis of student interviews were developed using student interviews and photographs to understand students' experiences of PS in the maker clubs. The themes that emerged from this study included- *discussing projects, iterating using photographs, and making memories.*

Emergent themes	**Selected student quotes**
Discussing projects	"It was a car, a bike car thing; It can go in water and withstand anything. It is indestructible. However, it is pricey, and it is dangerous. You would need a special license for this."
	"I made a book, and I just put random pictures on the cover of the book and in the back of the book of occupations, like a police officer, the construction worker, and a firefighter."
	"Okay, so this was my first project, where I was trying to make a pickax; as you see right here [pointing to a photo], it was made out of blocks, And now the blue blocks are here."
Iterating using photographs	"Yeah. That they [photos] are right in front of you, I can use it to revise my projects? Like these kinds of pictures [pointing to a developed physical photo], because it shows the mistakes you made."
	"I could clock the project at different stages. Yeah, that was an objective to take pictures of the process."
	"I took a picture of a problem I had [with] my final project, something I built, some Lego things I built."
Making memories	"Because it would remind me to remember what I have done in the past year. And so I can look over it again and get an idea of what I can do for next year."
	"So I am going to put all these in my journal, and that could be something I have for memory, right?"

	“Keep them for my memories.”

The following table represents the percentage of photographs that match the three themes. This was calculated by asking the students what each photograph meant and the purpose of taking each photo. Our team noted the reasons and then matched them to the emerging themes.

Theme	**Percentage of photographs that matched the theme** (Some photos fit into multiple themes as indicated by our students, which resulted in the total percentage being above 100%/)
Discussing projects	81.69%
Iterating using photographs	39.43%
Making memories	31%

The teachers’ interviews yielded two main themes complementary to the students: *making memories and increased engagement in their projects.*

Themes	**Teacher quotes**
Making Memories	as “... a great way to document what was going on in real life in the classroom and giving the students an opportunity to use that in their journals.”
	“One of the things that was different this year was that we gave them more film to take pictures and to collect memories.”
Increased engagement in their projects.	“[Students] do not come to the club every session but are always invested. They find me in the hallways and ask, "What are we doing now? What can I work on at home?"
	“It was a club, majority of boys, and I told them the car project came really for them, doing the motor project, and I saw how interested…”

Photographs

Student comment: “These are pictures of my block design, and my iterations are in photographs.”

Student comment: “This is a picture of the coffin I am making, and every time I make a mistake, I take a photo to see where the mistake happened.”

Sustainability and Dissemination

We have taken many steps to scale this project beyond the initial funding period by considering sustainability and feasibility for our school partners throughout the program’s development. We created a website that provides two sets of curricula, the related slide decks, and videos of implementation tips from educators who have run the program. Educators can access these materials from this website at no cost [Link: https://ideas.edc.org/]. We recruited a cohort of six Occupational Therapists (OTs) from NYC Public Schools and trained them to coach professional development (PD). After the funding ends, these coaches will continue to provide PD to educators in the district. We have conducted PD with nearly a hundred educators (teachers and OTs) prior to the program ending and have provided training to additional educators at conferences and museums. The Photovoice-related projects were incorporated into two middle school clubs, and teachers were trained to independently train students to use the cameras and photography as part of their club sessions. We provided both schools with resources and supplies to continue using Photovoice in their program.

We also adopted some approaches that included the broader interests of our students. The IDEAS maker program ensured its sustainability and flexibility by inviting students and teachers to incorporate making into everyday learning and teaching activities [6]. Students could pursue any interests within engineering (e.g., circuits (electrical engineering), 3D printing, programming, robotics, and building motors or combine them in their final projects [20]. By engaging in these interest-driven activities, students could learn concepts more deeply and engage with theoretical concepts uniquely [21]. We also developed the World Building curriculum, which included crafts and art-based design to match the needs and interests of younger students. However, this program was also adopted by some middle schools to ensure students could be exposed to a diversity of activities. For high-schoolers, we are currently tailoring their learning needs and interests in a mentoring program that matches autistic (high schoolers)-autistic (undergraduate college degree) students based on their interests. Since these changes are currently being implemented in schools, we will be measuring their impact in the future.

Limitations and challenges

Despite the positive impacts highlighted in the results, our work is not without limitations. Our maker clubs included students at or above grade level with relatively low support needs participating alongside their peers in a traditional classroom setting. This could impact the transferability of this study's results to other contexts, as autistic students vary significantly in their individual learning needs. Similarly, most of our students could communicate using spoken language, which could also affect its transferability to other contexts with non-speaking autistic students. Future research can focus on autistic students with higher support needs and understanding their experiences of participating in these clubs by adapting the structure of maker clubs to accommodate and include their needs.

Our programs included a rigorous PD component, which played a role in the implementation process as teachers and OTs received training. Replicating this program could be challenging if there are funding shortages or a lack of trained professionals who adopt strength-based philosophies in their practices.

Conclusion

The results of this study have implications for other programs that intend to champion autistic adolescents as research partners contributing to the data collection process of a research study. By adopting an approach that democratizes the power dynamic between the researcher and the participants, adolescents can be empowered to take ownership of the research process that has crucial implications for their well-being. Students highlighted that when they took photos of their projects, they could discuss them in greater depth due to the visual scaffolding provided by the photos. This facilitated their ability to communicate their ideas and project-related details to the research team, their peers, and their families. Furthermore, using photographs as a visual reminder, we noted that students could iterate their projects in-depth and at their own pace. They could visualize their errors or shortcomings and iterate their prototypes. Taking photographs also enabled students to cherish memories from the maker club with their peers or as they developed their projects. Many students transitioning from middle school took pictures of their friends and teachers to make memories.

At the end of this work-in-progress project, we intend to disseminate the results and equip our teachers with resources to continue using Polaroid cameras so students can continue collecting photographs of their projects. We also intend to share our curriculum and dissemination products on the website, including presentations, accepted journal articles, and student photographs.

Please note: Disclaimer

This paper will use the identity-first language, for example, terminologies like "autistic individuals." This non-ableist language describes their strengths and abilities and is a conscious decision. Autistic communities and self-advocates favor this language, and it is increasingly adopted by healthcare professionals and researchers [27].

Acknowledgments

The National Science Foundation's ITEST #1850289 grant made funding for this project possible. We want to sincerely thank our students and teachers for their profound contributions to the development of this study and the program. The opinions, findings, conclusions, or recommendations presented in this material are those of the authors and do not necessarily represent the views of the National Science Foundation.

References

[1] Moore, T. J., Glancy, A. W., Tank, K. M., Kersten, J. A., Smith, K. A., & Stohlmann, M. S. A Framework for Quality K-12 Engineering Education: Research and Development, *Journal of Pre-College Engineering Education Research (J-PEER)*, 4(1), Article 2, 2014. [Online]. Available: https://doi.org/10.7771/2157-9288.1069 [Accessed May 20, 2023].

[2] Stehle, S. M., & E., E. Developing students' 21st Century skills in selected exemplary inclusive STEM high schools. *International Journal of STEM Education,* 6(39), 1-15, 2019. [Online]. Available:https://doi.org/10.1186/s40594-019-0192-1. [Accessed June 10, 2023].

[3] Ehsan, H., Rispoli, M., Lory, C., Gregori, E. A Systematic Review of STEM Instruction with Students with Autism Spectrum Disorders. Review *Journal of Autism and Developmental Disorders,* 5, 327–348. 2018. [Online]. Available: https://doi.org/10.1007/s40489-018-0142-8. [Accessed June 23, 2023].

[4] Roehrig, G. H., Moore, T. J., Wang, H. H., & Park, M. S. Is adding the E enough? Investigating the impact of K‐12 engineering standards on the implementation of STEM integration. *School Science and Mathematics,* 112(1), 31-44. 2012. Available: https://doi.org/10.1111/j.1949-8594.2011.00112.x. [Accessed July 23, 2022].

[5] Papavlasopoulou, S., Giannakos, M. N., & Jaccheri, L. Reviewing the affordances of tangible programming languages: Implications for design and practice. *IEEE Global Engineering Education Conference (EDUCON), April 25-28 April 2017,* Athens, Greece https://doi.org/10.1109/EDUCON.2017.7943096. 1811–1816.

[6] Martin, W. B., Yu, J., Wei, X., Vidiksis, R., Patten, K. K., & Riccio, A. Promoting science, technology, and engineering self-efficacy and knowledge for all with an autism inclusion maker program. *Frontiers in Education,* 5. 2020. [Online]. Available: https://doi.org/10.3389/feduc.2020.00075. [Accessed January 23, 2021].

[7] Wang, C., & Burris, M. A. Photovoice: concept, methodology, and use for participatory needs assessment. *Health education & behavior: the official publication of the Society for Public Health Education,* 24(3), 369–387. 1997. [Online]. Available: https://doi.org/10.1177/109019819702400309. [Accessed March 18, 2021].

[8] Kornblau, B.L. & Robertson, S.M. Special Issue on Occupational Therapy With Neurodivergent People. *American Journal of Occupational Therapy.* 75(3), 7503170010. 2021. [Online]. Available: https://doi.org/10.5014/ajot.2021.753001 [Accessed March 18, 2022].

[9] Gaudion, K., Pellicano, L. The Triad of Strengths: A Strengths-Based Approach for Designing with Autistic Adults with Additional Learning Disabilities. In: Marcus, A. (eds) Design, User Experience, and Usability: Design Thinking and Methods. DUXU 2016. Lecture Notes in Computer Science, vol 9746. Springer, Cham. 2016.

[10] van Wijngaarden-Cremers, P. J. M., E. van Eeten, W. B. Groen, P. A. Van Deurzen, I. J., Oosterling, and R. J. Van der Gaag. Gender and Age Differences in the Core Triad of Impairments in Autism Spectrum Disorders: A Systematic Review and Metaanalysis. *Autism Developmental Disorder,* 44 (3): 627–635. 2014. [Online]. Available: https://doi.org/10.1007/s10803-013-1913-9 [Accessed March 18, 2022].

[11] Patten Koenig, K. "Authentic strength-based practice: Can Neurotypical professionals make a paradigm shift?" *Autism Spectrum News.* January 1, 2020. [Online]. Available: https://autismspectrumnews.org/authentic-strength-based-practice-can-neurotypical-professionals-make-a-paradigm-shift/ [Accessed March 18, 2020].

[12] Cahill, S. & Bazyk, S. "School-based occupational therapy." In *Occupational Therapy for Children and Adolescents,* J.O'Brien & H. Miller-Kuhaneck (Eds.), 8th ed. St.Louis: Elsevier. 2020, pp. 627-658.

[13] Bolton, T., & Plattner, L. Occupational Therapy Role in School-based Practice: Perspectives from Teachers and OTs, *Journal of Occupational Therapy, Schools, & Early Intervention,* 13 (2), 136-146. 2020. [Online]. Available: 10.1080/19411243.2019.1636749 [Accessed December 22, 2020].

[14] Pasqualotto, A., Mazzoni, N., Bentenuto, A., Mulè, A., Benso, F., & Venuti, P. Effects of Cognitive Training Programs on Executive Function in Children and Adolescents with Autism Spectrum Disorder: A Systematic Review. *Brain sciences,* 11(10), 1280. 2021. [Online]. Available: https://doi.org/10.3390/brainsci11101280 [Accessed December 22, 2020].

[15] Rodríguez C. The Construction of Executive Function in Early Development: The Pragmatics of Action and Gestures. *Human Development,* 66(4-5), 239–259. 2022. [Online]. Available: https://doi.org/10.1159/000526340. [Accessed January 22, 2023].

[16] Vuopala, E., Medrano, D.G., Aljabaly, M., Hietavirta, D., Malacara, L. & Pan, C. Implementing a maker culture in elementary school – students' perspectives, *Technology, Pedagogy and Education,* 29(5,) 649-664. 2020. [Online]. Available: 10.1080/1475939X.2020.1796776 [Accessed January 20, 2021].

[17] Dym, C. L., Agogino, A. M., Eris, O., Frey, D. D., & Leifer, L. J. Engineering design thinking, teaching, and learning. Journal of Engineering Education, 94(1), 104-120. 2005.

[18] Engineering Design Process. *Teach Engineering.* N.D. Available: https://www.teachengineering.org/design/designprocess [Accessed February 23, 2021].

[19] Grandin, T., & Panek, R. "The autistic brain: Thinking across the spectrum." Houghton Mifflin Harcourt Trade & Reference Publishers. 2013.

[20] Murthi, K. & Patten, K. Improving executive functions using the engineering design process: A peer-mediated problem-solving approach for autistic adolescents. American Journal of Occupational Therapy, 77(2), 7702347010. 2023. [Online]. Available: https://doi.org/10.5014/ajot.2023.050166 [Accessed July 20, 2023].

[21] Martin, W., Vidiksis, R., Koenig, K. P., & Chen, Y.-L. Making on and off the spectrum. *Connected Science Learning,* 1(10). 2019. [Online]. Available: https://www.nsta.org/connected-science-learning/connected-science-learning-april-june-2019/making-and-spectrum. [Accessed July 22, 2021].

[22] Chen, Y-L, Murthi, K., Martin, W., Vidiksis, R., Riccio, A., & Patten, K. Experiences of Students, Teachers, and Parents Participating in an Inclusive, School‑Based Informal Engineering Education Program. *Journal of Autism and Developmental Disorders.* 52, 3574–3585. 2022. [Online]. Available: https://doi.org/10.1007/s10803-021-05230-2 [Accessed July 20, 2022].

[23] Murthi, K., Chen, YL., Martin, W. Riccio, R. & Patten, K. Understanding STEM Outcomes for Autistic Middle Schoolers in an Interest-Based, Afterschool Program: A Qualitative Study. *Research in Science Education,* 2024.[Online]. Available: https://doi.org/10.1007/s11165-024-10158-5 [Accessed January 31, 2024].

[24] Wang, C. C. Photovoice: A participatory action research strategy applied to women's health. *Journal of Women's Health,* 8(2), 185-192. 1999.[Online]. Available: 10.1089/jwh.1999.8.185 [Accessed January 31, 2024].

[25] Nicolaidis, C., Raymaker, D., Kapp, S. K., Baggs, A., Ashkenazy, E., McDonald, K., Weiner, M., Maslak, J., Hunter, M., & Joyce, A. The AASPIRE practice-based guidelines for the inclusion of autistic adults in research as co-researchers and study participants. *Autism: The International Journal of Research and Practice*, 23(8). 2019. [Online]. Available: https://doi.org/10.1177/1362361319830523 [Accessed January 31, 2024].

[26] Clarke, V., & Braun, V. Thematic analysis. The journal of positive psychology, 12(3), 297-298. 2017.

[27] Bottema-Beutel, K., Kapp, S. K., Lester, J. N., Sasson, N. J., & Hand, B. N. Avoiding ableist language: Suggestions for autism researchers. Autism in adulthood, 3(1), 18-29. 2021. [Online]. Available: https://doi.org/10.1089/aut.2020.0014 [Accessed January 21, 2022].

Appendix

Interview questions for the photo-elicitation process

1. Can you describe this photo? What is happening in this picture?

2. Why did you take this picture?
    a. Is there something you like about this picture?
        i. If yes, can you describe what you like about it?
    b. If not, can you describe what you do not like about it? Is there anything you want to change about it?

3. Do you use the Engineering Design Process (EDP) to solve problems?
    a. If yes, can you explain more about how you use it?
    b. If not, then why don’t you use it? What do you use instead when you are stuck?

4. What did you think about collecting pictures for your project this year?
    a. Did you like it?
        i. If yes, why?
        ii. If not, why?