Board 407: The Use of Home Technology in Preschoolers' Families in Urban Settings: Experiences and Potential Impacts

Dr. Gisele Ragusa, University of Southern California

Gisele Ragusa is a Professor of Engineering Education at the University of Southern California. She conducts research on college transitions and retention of underrepresented students in engineering, PreK-12 STEM Education, ethics, socially assistive robotics, and also research about engineering global preparedness.

The Use of Home Technology in Preschoolers' Families in Urban Settings: Experiences and Potential Impacts

Abstract

Comprehensive experiences with science, technology, engineering, and mathematics (STEM) in pre-school settings can assist young students in learning about computer science and engineering prior to when they enter into K-12 classrooms. Such experiences are also an important way to attract more students to STEM careers. Currently however, the number of high-quality STEM education resources and materials available to preschool educators is limited. This is particularly the situation in areas of high poverty in communities that have been under-resourced longitudinally. This research addresses a gap in preschool teachers' capacity to support young children's STEM content knowledge by determining what sorts of technology is present in children's home, and how such technological experiences impact children's familiarization with and use of technology in preschool classrooms for children ages three-five. The presented study is part of a larger, National Science Foundation (NSF) funded project in which preschoolers, their teachers and their families experience an intervention to improve children's access to technology and experience in pre-engineering and early computer science education with their early childhood teachers.

The referenced "umbrella" study's research questions include: (1) In what ways does the project's infusing of play-based early computer science and pre-engineering into child development programs impact young children's early computer science and pre-engineering knowledge, and their knowledge of and early interest in STEM careers? (2) What is the relationship between the project's teacher professional development and participating teachers' content knowledge of early computer science and pre-engineering and instructional performance? (3) What impact does the teachers' cyber-safety focused professional development have on the cyber-safe practices of participating preschool teachers and their young students? And (4) What role do young students' early technology experiences play in their comfort with, interest in, and understanding of technology use?

The full research project referenced above employs a teacher professional development program that allows preschool educators and university STEM faculty to co-create materials and engage in teacher professional development together. This is "work in progress" research during its second year in operation with NSF funding. In the first year of the project, the research team engaged in research on the needs of teachers in diverse early childhood education settings. These results were presented last year (2023) at ASEE.

This 2024 ASEE paper responds to the fourth research question (above) of the referenced larger early education study regarding children's use of and comfort with technology. This question was included in the research because the literature suggests that frequency of use of technology and familiarization with technology increases young students' interest in STEM majors in college and careers; so as researchers, we wish to determine the level of interest, experience and comfort with technology young children have in their homes and how that may impact their in-class technology familiarization and use. This is of particular importance for the population

engaged with this research because 92.3% of them are considered under-resourced financially by federal poverty standards.

For the present paper, we collected research data using a family/primary caregiver questionnaire on the use of technology in children's home who are in the preschools in which the teacher participants for the larger study teach. This questionnaire collected information about the types of technology the children have in their homes, whether the young children in the families witnessed use of the technology, (a proxy for learning vicariously from about technology), whether they used the technology themselves, and then compared that information to the children's use, familiarization and comfort with using technology in their preschool classroom. Results of this research indicated that the majority of the preschool children had only experiences using a smart phone or television, either vicariously or directly. Nearly 100% of the children had access to television. Of those who had smart phones in their home 64.1 percent had direct experience playing with a smart phone. Only 26% of the children had experiences with computers and these experiences were primarily vicarious, watching either a parent, other adult, or an older sibling using a computer. Very few children used a robot at home, a few had access to an e-tablet, and a very small number of children had access to musical technology. The connections to use in the classroom were rather profound. Of those who used technology other than a TV, the more frequent and the variability in technology use, the more comfortable the children were with in-class technology use per their families.

Introduction and overview

Comprehensive experiences with science, technology, engineering, and mathematics (STEM) in the pre-school settings can assist young students in learning about computer science and engineering in classrooms. Such experiences are also an important way to attract more students to STEM careers. Currently however, the number of high-quality STEM education resources and materials available to preschool educators and their students is quite sparse. This is particularly the case in areas of high poverty in communities that have been under-resourced longitudinally.[1,2] This research addresses a gap in preschool teachers' capacity to support young children's STEM content knowledge by determining what sorts of technology is present in children's home, and how such technological experiences impact children's familiarization with and use of technology in preschool classrooms for children ages three-five.

Review of relevant research on early childhood education in pre-engineering and computer science

Research on STEM education in early childhood settings is relatively sparse. Moreover, that which has been conducted is typically small in scale. Current research indicates that a critical determinant of what young children learn is the content knowledge and pedagogical expertise of their early teachers, parents and caregivers; who are most often children's first "teachers."[3] Unfortunately, most preschool educators have little or no content knowledge in computer science or engineering, and unless parents and other caregivers of preschoolers come from engineering or computer science backgrounds, there is sparse likelihood that this content will be a major part of their children's early educational experiences.[4,5] Importantly, the current curricular frameworks in early childhood education programs address early mathematics, but have minimal

content requirements in science, and virtually no engineering or computer science content. Therefore, not only are early childhood educators underprepared for teaching computer science and engineering, they are not yet expected to teach such content in child development settings, be it parent or child focused. This is especially unfortunate because children in early education must be prepared to meet the increasing demands found in the nation's Next Generation Science Standards beginning in kindergarten; however, they come to K-12 without having substantive background knowledge in these important technologically focused content areas.

The National Research Council's (NRC's) Committee on Informal Science Learning has recognized that adult caregivers, peers, and early educators play a critical role in supporting science learning in formal and informal settings. They do this via a range of discrete acts of assistance to long-term, sustained relationships, collaborations, and apprenticeships.[6] This research is guided by this NRC Committee's recognition. In concert with this, the research will advance the evidence-based knowledge in early childhood computer science and engineering education in diverse environments (in child development programs and homes) for families and their children before they enter kindergarten.

Figure 1: Students introduced to technology through play

There is a growing understanding and recognition of the importance of children's beginning learning as well as a belief that computer science and engineering may be particularly important domains in young children's lives, serving not only to build a basis for developing important STEM skills and attitudes for learning.[7] Katz and colleagues conducted research in which they began to recognize that children begin pre-engineering understanding if they are allowed to play with and experience technology and building opportunities before they enter first grade. Accordingly, it is important to cultivate such interest in making things work, building things, and exploring technology mediated and engineering focused problem solving early on, in preschool and with families, before children transition to kindergarten as a means of developing STEM interest.[8] Meeteran and Zan posit that young children imitate "fix it" type behaviors such that they modify their play environments based on what they have access to and experiences with. Accordingly, as a mediating step in our research, we found it necessary to determine what children have at home to engage with in technological and pre-engineering realms.[9] Researchers purport that to make early STEM education effective, the learning must occur in integrated settings [10] and must be situated in what is developmentally appropriate for young learners, and their families; essentially through play.[11,12,13] Furthermore, as portable technologies have become ubiquitous,[14,15,16,17] even for families with financial challenges and with limited resources, it is of importance to inform families about learner-centric, developmental ways to effectively introduce technologies to young children.[18,19]

Methodological approach

This work in progress referenced study's research question is: *What role do young students' early technology experiences play in their comfort with, interest in, and understanding of technology use?* This is "work in progress" research during its second year in operation. In the first year of the project, the research team engaged in research on the needs of teachers in diverse early childhood education. These results were presented last year (2023) at ASEE (see author's note at end of manuscript.) This 2024 paper submission responds to a research question (above) of the referenced larger early education study regarding children's use of and comfort with technology use. This question was included in the research because the literature suggests that frequency of use of technology and familiarization with technology increases young students' interest in STEM majors in college and careers; so as researchers, we wished to determine the level of interest, experience and comfort with technology young children have in their homes and how that may impact their in-class technology familiarization and use. This is of particular importance for the population engaged with this research because 92.3% of them are considered under-resourced financially by federal poverty standards.

For the present paper, we distributed a family questionnaire on the use of technology in children's home who are in the preschools in which the teacher participants for the referenced larger study. The questionnaire was administered in three languages and was distributed electronically via a secure web-link on a survey platform. It was sent via email to parents in preschool and other early childhood programs across the state. It was an 11-item Likert type questionnaire which also included sociodemographic items to describe the population and an open response item in which the parents or primary caregivers were asked to describe their technology use at home and in other settings. In particular, the questionnaire items collected information about the types of technology the child(ren) had in their homes, whether the children in the families witnessed use of the technology, (a proxy for learning vicariously from about technology), whether they used the technology themselves, and then compared such information to the children's use, familiarization and comfort with using technology in their early education classroom (via parent/caregiver report). Information on the frequency of technology use was also collected and compared to other sociodemographic characteristics in the families.

A total 427 families participated in the study with 66% of families responding to the English version, 29% responding to Spanish version and the remaining responding to the Chinese version of the questionnaire. Their ethnicities were diverse with 42% of the participants self-identifying as European American decent, 31% self-identifying as of Hispanic/Latinx decent, 12% of African American decent, and the remain of various Asian American backgrounds. In terms of parents'/primary caregivers' educational background, 62.5% had high school diplomas, 19% also completed some college coursework, 3.4% completed a college degree, and only 2 parents/caregivers had an advanced degree. As described previously, 92.3% of the family participants are considered under-resourced economically.

In terms of data analyses from the questionnaire, descriptive statistics and comparative correlational analyses were computed to analyze the Likert-type items and the sociodemographic items in the questionnaire. Thematic analyses were conducted to understand and interpret the open-ended item on the questionnaire.

Notably, as described in the paper's abstract, the presented study is part of a larger, NSF funded project in which preschoolers, their teachers and their families experience an intervention to improve children's access to technology and experience in pre-engineering and early computer science education via professional development with their early childhood teachers.

Results

Results of this research are interesting and diverse. There are both quantitative and qualitative results included in the study. Descriptively, the results of this "work in progress" study indicate that the majority of the preschool children whose parents or caregivers we surveyed had only experiences using a smart phone or television, either vicariously or directly. Nearly 100% of the children had access to television. Of those who had smart phones in their home, 64.1% had direct experience playing with a smart phone. Only 26% of the children had experiences with computers and these experience were primarily vicarious, watching either a parent, other adult, or an older sibling using a computer. Very few children used a robot at home (less than 3%), a few had access to an e-tablet (9.4%), and a small number of children had access to musical technology (.89%). Comparatively (as determined via correlational analyses), the connections to use in the classroom were rather profound. Of those who used technology other than a TV, the more frequent and the variability in technology use, the more comfortable the children were with in-class technology use ($r=.544$, $p<.01$). The parents' educational status was also highly correlated to the amount and diversity of the technology their families had in their homes ($r=.912$, $p<.001$). The parental education was also highly correlated to the frequency of use of technology ($r=.794$, $p<.001$).

Figure 2: Students exploring technology use with anticipatory guidance

Qualitatively, the families and caregivers who participated in this research were asked to describe the technological experiences that they provide to their children in their homes. The results of the responses to this open-ended question were analyzed thematically by category of response and the results of these responses are represented in Table 1 below. Notably, 68% of the participants completed the open-ended response.

Table 1: Parent/caregiver description of technological experiences

Category of Use Location	Frequency of Response (~%)	Example Response
Smartphone in home	72%	"I use my phone a lot at home so she's used to it and grabs it to play with it whenever she can."

Smartphone elsewhere	79%	"I know I shouldn't but I use my phone as an 'electronic babysitter' in restaurants or when we have to be quiet in public places."
Tablet in home	14%	"I cue up videos for her to watch for quiet time when my baby is sleeping."
Tablet elsewhere	21%	"They love my iPad. I have it in my bag so they look for it especially when we need to sit for a while."
Television in home	44%	"We don't watch much TV, but I must admit I use this for quiet times… my son does not nap anymore. We often play videos. I wish there were more educational games on TV for him."
Television elsewhere	13%	"It all depends on who has a TV. My mom uses when she babysits."
Computer in home	9%	"We have a very old computer but it does the trick."
Computer elsewhere	<1%	" We have used a computer at the school and sometimes at my sister's house. It seems a hard for them."
Robot in home	<1%	"My older son got a robot as a present and he (younger son) likes to try it. It's hard for him. Maybe I can get them to play together with it."
Robot elsewhere	<	" I think her school has a robot for them to play with."
Other tech. in home	5%	"My older son is in college and he has lots of technology. He likes playing with the younger kids and teaching them how to use stuff."
Other tech. elsewhere	2%	" My neighbor has videogames. They pretend to play with them. Not sure they know how to."

NOTE: Many participants described many instances of technology use.

These results (above) indicate that preschoolers have access to technology and somewhat surprisingly at other people's homes and in public places. These results speak to the relatedly ubiquitous use of technology by families regardless of resources. The results in types of use are not surprising and mimic to some degree other research and even that with older K-12 learners. [20] When comparing qualitative responses to quantitative responses, the children's level of comfort with technology was highly correlated to diversity of use in technology from the open-ended responses ($r=.394$, $<.05$). It is interesting that many parents/caregivers reported using technology to quiet their child (or during quiet times) rather than for times to engage with them. Perhaps the need for techniques of strategic use of and engagement with technology in home is an important component for the intervention work. Moreover, the results further underscore the importance of a need for cyber-safety training for families, which is a tenet of the larger intervention research of which this study is a component given families' ubiquitous use of technology for varying purposes.

Discussion and future work

As previously described, this early education research is a “work in progress” opportunity. These formative results not only have informed the design, development and implementation of a large scale, multi-year teacher professional development and associated curriculum project in early education STEM and cyber-safety. The study’s results also inform future research on the implementation of such work. Accordingly, given that this is a work in progress paper, in future years of the research, the project will test the development of its intervention as a STEM intervention for teachers and families using a large scale randomized controlled trial. Furthermore, in its full implementation, this research aims to produce a fully tested set of bilingual, bicultural early childhood STEM materials for national dissemination.

References

1. A. Ayob. *Technical report on the implementation of STEM education in early childhood education in Malaysia.* STEM for PERMATA Negara. Office of the Prime Minister Department. Putrajaya. Government of Malaysia. 2015.
2. J.D. Chesloff. Why STEM education must start in early childhood. *Education Week,* 32(23), 2013. 32-33.
3. Draper, C.L., & Wood, S. From Stumble to STEM: One School's Journey to Explore STEM with its Youngest Students. *Exchange (Infants and Toddlers)* January/February 2017, 61–65.
4. E.R. McClure, E.R., L. Guernsey, D.H. Clements, S.N. Bales, J. Nichols, N. Kendall-Taylor, and M.H. Levine. 2017. *STEM Starts Early: Grounding Science, Technology, Engineering, and Math Education in Early Childhood.* New York: The Joan Ganz Cooney Center at Sesame Workshop.
5. NSTA (National Science Teachers Association). "Early Childhood Science Education." Position statement. 2014. www.nsta.org/about/positions/earlychildhood.aspx.
6. National Research Council. *STEM Learning Is Everywhere: Summary of a Convocation on Building Learning Systems.* S. Olson & J. Labov, Rapporteurs. Planning Committee on STEM Learning Is Everywhere: Engaging Schools and Empowering Teachers to Integrate Formal, Informal, and Afterschool Education to Enhance Teaching and Learning in Grades K-8, Teacher Advisory Council, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. 2014.
7. C. A. Haden, E.A. Jant, P.C. Hoffman, Marcus, M., Geddes, J. R., and S. Gaskins. Supporting family conversations and children's STEM learning in a children's museum. *Early Childhood Research Quarterly*, *29*(3), 2014. 333-344.
8. L. G. Katz, and S. C. Chard. *Engaging children's minds: The project approach* (2nd ed.). Stamford, CT: Ablex. 2000. 81-124.
9. V. B Meeteren and B. Zan. Revealing the Work of Young Engineers in Early Childhood Education. Early Childhood Research & Practice; Seed Papers, 2010.
10. Quigley, Cassie, Pongason, K., & Akerson, V.L. If we teach them, they can learn: Young students views of nature of science aspects to early elementary students during an informal science Education program. *Journal of Science Teacher Education*. 21(7). 2010. 887-907.
11. K. Worth. *Science in early childhood classrooms: Content and process.* Paper presented at STEM in Early Education and Development Conference, Cedar Falls, IA. 2010.
12. Bakırcı, Hasan, Karışan, and Dilek. Investigating the Preservice Primary School, Mathematics and Science Teachers' STEM Awareness. Journal of Education and Training Studies. 6. 32. 2017. 10.11114/jets.v6i1.2807.
13. R. K Gelman, K. Brenneman, G. Macdonald, and M. Roman. *Preschool pathways to science: Ways of doing, thinking, communicating and knowing about science*. Baltimore, MD: Brookes Publishing.
14. National Association for the Education of Young Children (NAEYC). 2013. All criteria document, 17–18. Retrieved from http://www.naeyc.org/files/academy/file/AllCriteriaDocument.pdf
15. N. K. DeJarnette. Implementing STEAM in the Early Childhood Classroom. European Journal of STEM Education, 3(3), 2018. 18.
16. G. Fessakis, E., Gouli, and E. Mavroudi. Problem solving by 5–6 years old kindergarten children in a computer programming environment: A case study. Computers & Education, 63, 2016. 87-97. Doi:10.1016/j.compedu.2012.11.016
17. C. Copple and S. Bredekamp, eds. *Developmentally Appropriate Practice in Early Childhood Programs Serving Children from Birth Through Age 8.* 3rd ed. Washington, DC: NAEYC. NSTA (National Science Teachers Association). Parent Involvement in Science learning. NSTA position statement. 2009. www.nsta.org/about/positions/parents.aspx
18. G. Ragusa. The Impact of a Pre-Engineering Professional Development Program on Teachers' Understanding and Developmentally Appropriate Practices in Using Technology in Diverse Early Childhood Settings. *Conference Proceedings ICERi 2023- 6th annual International Conference of Education, Research and Innovation,* 2023 Seville, Spain.
19. G. Ragusa and L. Leung. Enhancing Early Childhood Educators' Knowledge of Computer Science and Engineering Concepts to Spark Young Children's Early Interest in STEM Careers. *2023 American Society for Engineering Education Conference Proceedings.* Session AC-2023 37688, Baltimore, MD.
20. G. Ragusa, S. Levonisova, and S.. Huang. Improving Middle School Science Achievement, Literacy and Motivation: A Longitudinal Study of a Teacher Professional Development Program. *Journal of STEM Education: Innovations and Research. 23(4)* 2022. *22-35.*

Work in progress disclaimer and IRB approval

Portions of this manuscript have been paraphrased in a 2023 ASEE paper because this is a publication that represents an NSF funded "work in progress" paper. These components are primarily a portion of the review of the literature because such information sets the stage for the overall research and provides important research context. The overall research approach is also paraphrased in the previous 2023 work in progress manuscript so that the reader may understand the research context. All other paper elements are unique to this manuscript. This research is approved by the lead author's university's institutional review board (IRB) for human subjects research and photo release for both adults and minors.

NSF acknowledgement

This research is based upon work supported by the National Science Foundation under Grant #2148777. Any opinions, findings, conclusions, or recommendations expressed in this material are those of the author and do not necessarily reflect the views of the National Science Foundation.