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THE IMPACT OF TEACHER GENDER ON GIRLS' PERFORMANCE ON PROGRAMMING TASKS IN EARLY ELEMENTARY SCHOOL

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ABSTRACT

Aim/Purpose	The goal of this paper is to examine whether having female robotics teachers positively impacts girls' performance on programming and robotics tasks
Background	Women continue to be underrepresented in the technical STEM fields such as engineering and computer science. New programs and initiatives are needed to engage girls in STEM beginning in early childhood. The goal of this work is to explore the impact of teacher gender on young children's mastery of programming concepts after completing an introductory robotics program.
Methodology	A sample of *N*=105 children from six classrooms (2 Kindergarten, 2 first grade, and 2 second grade classes) from a public school in Somerville, Massachusetts, participated in this research. Children were taught the same robotics curriculum by either an all-male or all-female teaching team. Upon completion of the curriculum, they completed programming knowledge assessments called Solve-Its. Comparisons between the performance of boys and girls in each of the teaching groups were made.
Findings	This paper provides preliminary evidence that having a female instructor may positively impact girls' performance on certain programming tasks and reduce the number of gender differences between boys and girls in their mastery of programming concepts.
Recommendations for Practitioners	Practitioners should expose children to STEM role-models from a variety of backgrounds, genders, ethnicities, and experiences.
Keywords	gender, STEM, robotics, programming, early childhood

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INTRODUCTION

In most career fields, female participation has been on the rise over the past decade. This has not been the case, however, for many STEM (Science, Technology, Engineering, Mathematics) fields, especially technology and engineering fields (National Center for Science and Engineering Statistics, 2013; National Center for Women and Technology, 2011; National Science Foundation, 2017). In 2009, only 11% of undergraduate Computer Science degrees from major research universities were granted to women. According to the National Science Foundation (2017), the fields of computer science, physics, and engineering are all overwhelmingly male. In the past decade, both the number and proportion of computer sciences bachelor's degrees earned by women has declined (National Science Foundation, 2017). In the professional world, women make up less than 15% of engineers and only 25% of computer and math scientists (National Science Board, 2014).

These statistics have prompted researchers and educators to develop strategies for reaching girls and young women and to support them in pursuing technical subjects such as computer programming and engineering. There has been a surge in nonprofit organizations that have devoted energy to researching and improving the gender gap in these fields including: the American Academy of University Women (AAUW), Tech Bridge, Girls Who Code, and more. These organizations have not only investigated the gender gap, but have also attempted to bridge the gap by offering after-school STEM programs for girls, scholarships and grants for girls pursuing STEM in college, mentorship programs, and more.

A major focus of many of these programs is providing girls with female role models and mentors from technology and engineering fields. Prior research on the impact of same-gendered role models and students' interest and performance in STEM fields has come up with varied results (Drury, Siy, & Cheryan, 2011). While many initiatives focus on providing girls with female role models (e.g., MIT's Women's Initiative) some researchers have found that role model gender is less important than combating current stereotypes of people in STEM fields (Cheryan, Meltzoff, & Kim, 2011). However, most of this research is done with adults or teenagers. There is less research looking at the impact of same and different gendered teachers and role models on young children. This pilot-study begins to fill this gap by exploring the role of female and male robotics teachers on young children's (Kindergarten through second grade) performance on robotics and programming assessments and projects.

LITERATURE REVIEW

THE GENDER DIVIDE IN TECHNOLOGY AND ENGINEERING

Men continue to outnumber women in many STEM careers, particularly the technical STEM fields of engineering and computer science (National Science Foundation, 2017). This gender disparity becomes evident long before men and women enter the professional world. It begins in elementary school and becomes evident by the time boys and girls reach middle and high school. By the time boys and girls reach adolescence, research has shown that boys display significantly more interest, confidence, and skills in many STEM fields. During middle school, the gender gap begins to grow noticeably in terms of standardized STEM test scores and STEM course taking (Corbett & Hill, 2015; Spielhagen 2008). By the time they reach high school, boys are more likely than girls to take the standardized exams most closely associated with the fields of engineering and computing (Corbett & Hill, 2015). Females in high school are less likely to decide to take Advanced Placement (AP) level Computer Science classes or express interest in pursuing an undergraduate Computer Science major (Doerschuk, Liu, & Mann. 2007; Gal-Ezer & Stephenson 2009; Zweben & Bizrot 2015). Opting out of these critical courses and exams contributes to women's under-representation in STEM-related majors in college and STEM-related careers after college.

This is a problem. Diversity of genders, race, ethnicities, and experiences in the STEM workforce is sorely needed, not only to promote creativity and innovation, but to ensure that a representative range of views are considered in the design of products and tools. Closing the gender gap between men and women in STEM may also be beneficial – and profitable – for business. Companies in the top quartile for gender diversity are 15 percent more likely to have financial returns above their respective national industry medians (Hunt, Layton, & Prince, 2015). For these reasons, along with the ethical need to ensure equal opportunities for men and women, researchers have focused on understanding and eradicating the gender divide in STEM.

Why the Gender Divide?

In order to investigate this gender disparity, many researchers have theorized that a phenomenon known as "stereotype threat" explains why women and girls underperform in STEM fields. Stereotype threat refers to the anxiety that one's performance on a task or activity will be seen through the lens of a negative stereotype (Spencer, Steele, & Quinn 1999; Steele, 1997). For example, Spencer, Steele, and Quinn (1999) found that women performed significantly worse on a math test if they were first shown information indicating that women do not perform as highly as men on math tasks (to induce the negative stereotype). If the negative stereotype was not triggered (i.e., participants were told that there were no gender differences associated with the math test) women and men performed similarly on the test.

One of the ways to combat stereotype development is to reach children early. Basic stereotypes begin to develop in children around two to three years of age (Kuhn, Nash, & Brucken, 1978; Signorella, Bigler, & Liben, 1993). As children grow older, stereotypes about sports, occupations, and adult roles expand, and their gender associations become more sophisticated (Sinno & Killen 2009). Prior work demonstrates the importance of piquing the interest of girls during their formative early childhood and elementary years before gender stereotypes regarding these traditionally masculine fields are ingrained in later years (Metz, 2007; Steele, 1997).

Despite this, the majority of technology and engineering educational initiatives for girls focus on the middle and high school years and not the critical early childhood years (Bers, 2008; Bers, Seddighin, & Sullivan, 2013). One of the goals of the current study is to describe an initiative that takes place during the foundational early childhood years in order to expand the scope of research on STEM interventions for girls.

Impact of Role Models

In addition to reaching girls early, recent research has also demonstrated that increasing the number of female mentors in K-12 settings may have a positive impact on girls' experiences in STEM fields. In a 2011 study of students enrolled in a calculus class, results demonstrated that both female and male students participated more and asked more questions if the class was taught by a female rather than male professor (Stout, Dasgupta, Hunsinger, & MacManus, 2011). For female students, having a female rather than male professor also increased implicit liking of math and they identified more with math and their professor (Stout et al., 2011). In a study of engineering majors, having a female role model was related to persistence in engineering (Amelink & Creamer, 2010).

However, not all prior research has supported the idea of female role models increasing girls' interest in STEM, especially when these role-models are presented as hyper-feminine. For example, Betz and Sekaquaptewa (2012) have found that feminine STEM role models actually reduced middle school girls' interest in math and self-related ability as compared to gender-neutral role models. Some experts believe that by highlighting differences between boys and girls, unintended effects of reinforcing stereotypes emerge (Docterman, 2014).

The Present Study

Most of the prior research on the impact of same-gendered role models on girls' engagement with STEM is with girls in middle school, high school, and older. There is very little research on the impact during early childhood and early elementary school. The present research study aims to fill in this gap by examining the impact of female robotics instructors on girls' mastery of concepts in Kindergarten through second grade. This study asks the following research question: Does the gender of instructor impact girls' mastery of robotics and programming concepts?

Methods

In order to determine whether instructor gender impacts young girls' mastery of robotics and programming concepts, children in grades K-2 were recruited to participate in a robotics curriculum using an early prototype of the KIBO robotics kit. Children were taught the same robotics curriculum by either an all-male or all-female teaching team. Upon completion of the curriculum, participating children completed programming knowledge assessments called Solve-Its. Quantitative comparisons between the performance of boys and girls in each of the teaching groups were made. Full versions of KIBO curriculum, Solve-Its, and other research materials may be requested from the DevTech Research Group by visiting bit.ly/KIBOProtocolRequest.

Sample

A sample of *N*=105 children from six classrooms (2 Kindergarten, 2 first grade, and 2 second grade classes) from a public school in Somerville, Massachusetts, participated in this research. One Kindergarten, first grade, and second grade classroom was taught by a female robotics teacher with an all-female team of teaching assistants while the other Kindergarten, first, and second grade classrooms were taught by a male robotics teacher with an all-male team of teaching assistants. At the time of post-test data collection for this study, due to absences and other issues, a final sample of *n*=98 children are included in analysis in this paper (*n*=46 in the female taught group and *n*=52 in the male taught group).

This school was chosen in order to include a diverse and representative sample of the community. Nearly half (47.8%) of the school's students were reported as "economically disadvantaged" in the 2014-2015 school profile. 44.4% of the school's students speak a language other than English as their first language and 25.7% report some kind of disability. Children in this study came from homes that speak English, Spanish, and Portuguese as their primary language at home.

Robotics Curriculum

The robotics curriculum was taught over the course of seven weeks, and classes met once a week for approximately one hour. The curriculum used an early prototype of the KIBO robotics kit developed by the DevTech Research Group at Tufts University as part of the National Science Foundation funded Ready for Robotics project (See Figure 1). KIBO is designed for children ages 4-7 and consists of easy to connect parts including: wheels, motors, light output, and sensors (Sullivan, Elkin, & Bers, 2015). It is now commercially available through KinderLab Robotics.

Figure 1. KIBO robot and tangible block programming language

All of the parts of the KIBO robot are made of a mix of natural plywood and smooth plastic that is easy for young children to grip and manipulate. The sensors snap into place only when properly oriented, much like a puzzle. KIBO's actions are controlled with wooden programming blocks that have barcodes, each representing different actions for the robot to carry out. No screen-time from an iPad, tablet, or computer is required. KIBO's tangible language consists of twenty-one different programming blocks and twelve different parameters. With these blocks children can make KIBO move, light up, and make sounds. With more complex blocks and parameters, children can program KIBO to respond to stimuli in the environment with sensors.

Researchers and regular classroom teachers collaborated to develop a curriculum theme to introduce KIBO that would be appealing to boys and girls. The teachers were interested in a theme that would foster a sense of community and caring. They decided on the theme "Helpful Robots." Throughout the unit, children learned about robots that perform helpful jobs in the real world (such as hospital robots, educational robots, robots that help with household tasks like cleaning, etc.). As a final project, children worked in groups to create their own "Helpful Robot" to do helpful classroom jobs, teach important ideas, and demonstrate respectful behaviors and school rule.

Data Collection

Data was collected on children's individual KIBO programming knowledge at the end of curriculum implementation using the Solve-Its assessment. The Solve-It tasks were developed to target areas of foundational programming ability (Strawhacker, Sullivan, & Bers, 2013; Strawhacker & Bers, 2015). This assessment is intended to test students' mastery of programming concepts, from basic sequencing through repeat loops. The Solve-It tasks require children to listen to stories (that are read aloud by a researcher) about a robot and then spend 3-5 minutes attempting to create the robot's program using programming icons on paper (See Figure 2 below). For example, one story is about the bus from the children's song "Wheels on the Bus" (Strawhacker & Bers, 2015; Strawhacker, Sullivan, & Bers, 2013). For each Solve-It task, children were provided with paper programming blocks they needed to solve the task. The child's job was to put these blocks in the correct order to demonstrate their knowledge of KIBO syntax (for example, starting with a Begin block and ending with an End block or properly arranging control flow blocks)

Figure 2. Sample child-completed "Wheels on the Bus" Solve-It

Eight Solve-Its were administered to the children in this study upon completion of the curriculum. The eight Solve-Its tested the following programming concepts: Easy Sequencing, Hard Sequencing, Sequencing with the "Wait-For" Command, Easy Repeat Loops with Number Parameters, Hard Repeat Loops with Number Parameters, Easy Repeat Loops with Sensor Parameters, Hard Repeat Loops with Sensor Parameters, and Programming with Conditional Statements. Tasks were called "easy" or "hard" based on how many commands children needed to sequence (i.e., easy tasks had fewer blocks for children to sequence than hard tasks, but both addressed the same programming concept). Children were administered Solve-It tasks only if their class covered the targeted concept in their curriculum. For example, the Kindergarten group did not complete the last three Solve-It tasks because those concepts were not introduced to them.

Tasks were initially scored out of a possible 6 points (with 6 indicating a perfect score). In addition to looking at each of these eight Solve-Its individually, related concepts (such as easy and hard sequencing) were combined into a new cumulative score ranging from 0-12 possible points. The cumulative concepts included: Sequencing Cumulative, Repeats with Numbers Cumulative, and Repeats with Sensors Cumulative.

RESULTS

2-Way ANOVAs were performed to examine whether gender (male or female) or grade level (kindergarten, first, second) had a significant effect on students' performance on each of the following Solve-It tasks: Wait-For Clap, Sequencing Cumulative, Repeats with Numbers Cumulative, and Repeats with Sensors Cumulative. These four tasks were selected for ANOVA analysis because targeted discrete programming concepts were taught in two or more grades. In addition to determining whether grade or gender independently impact Solve-It scores, this analysis was also used to examine whether there was a significant interaction between the two independent variables (grade and gender) on Solve-It scores.

FEMALE TEACHING TEAM

Results from the 2-way ANOVAs showed that there were no significant main effects for gender ($p>.05$) and no significant interaction effects for grade and gender ($p>.05$) for any of the four tasks for the female-taught group. However, there was a significant simple main effect for grade level on the Wait-For Clap Solve-It $F(2,40) =7.746$, $p<.005$; on the Sequencing Cumulative Solve-It $F(2,40)= 12.062$, $p<.0001$; and on the Repeats with Numbers Cumulative Solve-It $F(2,40)=26.031$, $p<.001$. This indicates that on each of these tasks, grade significantly impacted students' performance on the respective Solve-Its but gender did not.

MALE TEACHING TEAM

The same analysis described in the previous section was performed on Solve-Its collected from the male teaching team group. 2-Way ANOVAs were performed on the following discrete tasks: Cumulative Sequencing, Cumulative Repeats with Numbers, Cumulative Repeats with Sensors, and Wait-For Clap. Results from the 2-Way ANOVAs show that there were no main effects for grade or gender alone on the Cumulative Sequencing task ($p>.05$), but that there was a significant interaction effect of grade and gender $F(2,46)$, $p<.005$. On the Cumulative Repeats with Numbers task there was a significant main effect for grade level $F(2,45)$, $p<.05$ and a significant main effect for gender $F(1,45)$, $p<.05$. Looking at the gender differences, we see that boys significantly outperformed girls with a mean score of 10.17 while girls had a mean score of 8.89 on this task. 2-Way ANOVAs on the Cumulative Repeats with Sensors task and the Wait for Clap task revealed no significant main or interaction effects ($p>.05$).

DISCUSSION

SUMMARY OF FINDINGS

Overall, this study showed that a male robotics instructor resulted in more gender differences between male and female students. However, the male instructor also resulted in fewer grade-level differences between students. This may be because the male-taught curriculum was implemented in the spring semester, after the kindergarteners were more accustomed to being in school and more familiar with completing individual tasks like the Solve-Its. This comfort may have resulted in the kindergarteners performing better on the assessment in the spring, resulting in fewer grade-based differences.

Results also showed that the male-taught intervention had a significant main effect for gender on the cumulative Repeats with Numbers task, with boys scoring significantly higher than girls. Meanwhile, the female-taught intervention did not result in any significant gender-based differences. This indicates that girls may perform better on mathematical programming tasks when taught by a female teacher. The following section explores the possible reasons for this as well as greater implications.

Does Teacher Gender Matter?

The results of this study provide some preliminary evidence that girls perform better on certain tasks when taught by female robotics teachers. This was the case when it came to the Repeats with Numbers task. Of all the Solve-It programming tasks that were implemented, this one was the most mathematical and involved explicit use of counting and numeracy in addition to general sequencing and coding concepts. In the United States there is a widespread belief that math is stereotypically a male domain (Lummis & Stevenson, 1990; Nosek et al., 2009). Prior research has shown that beginning in early elementary school, children demonstrate a cultural stereotype that math is for boys on both implicit and explicit measures (Cvencek, Meltzoff, & Greenwald, 2011). It is possible that for the Repeats with Numbers Solve-It task, this masculine stereotype was emphasized by having a male robotics teacher and therefore impacted girls' performance. Meanwhile, having a female teacher demonstrate expertise may have negated this stereotype.

There are also a range of confounding variables which may have led to this difference. For example, differences in teaching styles, experience, and confidence between the male and female teachers may have played a role. Future research with a larger sample of teachers will be important to pinpoint which of these variables (if any) along with teacher gender impacts girls' performance in programming.

However, it is important to point out that in both the male-taught and female-taught cohorts, the Solve-It scores indicate that both boys and girls gained a general mastery of the material taught. Additionally, it is important to note that there was only one task in which boys performed significantly better than girls in male-taught group, meaning that boys and girls generally demonstrated no difference regardless of teacher gender. Overall, when it came to learning coding concepts, implementing a KIBO robotics curriculum was beneficial to all children in the study.

Limitations

While this study benefited from a large sample of children, it consisted of only two lead robotics teachers, one male and one female. As such, these findings should be considered pilot findings and interpreted with caution. There may have been a range of influencing factors including teaching style, teaching experience, and more.

Additionally, data collection in public school settings are open to a range of confounding variables. There may have been other influences in the school day, other exposure to coding or robotics, and a range of other teachers and role models who may have impacted the experience for girls and boys in this study. Replication is needed to confirm the trends found in this study.

Future Research

This study should be replicated with a larger sample of male and female teachers to look at trends based on teacher gender. The present study was a small part of a larger project that was mainly looking at the experience with robotics for children. Therefore, data was not collected from teachers. Future research should focus on collecting surveys and interviews from teachers in STEM subjects to determine if there are any gender-based trends in approach or style.

The findings described in this paper focused on the impact of teacher gender on performance on a task. It did not look at the impact of teacher gender on girls' attitudes or interest in coding. Future research should look at not only mastery of content, but whether having a female robotics and coding instructor positively impacts girls' interest and enjoyment of subjects such as coding and engineering.

Finally, while this study focused on teachers and children in the school environment, the home environment is important to consider as well. Beyond teachers and professors, researchers have also found that a child's home environment can strongly influence the interests and personal goals of children (Bell, Lewenstein, Shouse, & Feder, 2009; Crowley & Jacobs, 2002). When it comes to a girl's developing interest and ideas about computers and technology, the role modeling of parents and parental expectation about ability and interest can change how girls see themselves with regards to computers and computing (Margolis & Fisher, 2002). According to Corbett and Hill (2015), "Parents also play an important role in exposing their children both to the fields of engineering and computing generally and to women in these fields at early ages, when their implicit biases are forming." Therefore, it is important to consider the role-modeling of parents, teachers, and peers and not just STEM mentors.

Conclusion

The present research begins to uncover the impact of teacher gender on young children's performance on programming tasks, particularly on a math related task. Results from this study provide preliminary evidence that having a female programming and robotics instructor may prompt girls to perform better on advanced coding concepts during a timed assessment. However, there were very few differences between the male-taught and female-taught groups. This indicates that boys and girls demonstrated high levels of mastery of programming regardless of teacher gender. Future research is needed in order to determine best practices for engaging girls in STEM beginning in early elementary school.

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References

Amelink, C. T., & Creamer, E. G. (2010). Gender differences in elements of the undergraduate experience that influence satisfaction with the engineering major and the intent to pursue engineering as a career. *Journal of Engineering Education, 99*, 81–92. https://doi.org/10.1002/j.2168-9830.2010.tb01044.x

Bell, P., Lewenstein, B., Shouse, A., & Feder, M. (Eds.). (2009). *Learning science in informal environments: People, places, and pursuits*. Washington, DC: National Academies Press.

Bers, M. U. (2008). *Blocks, robots and computers: Learning about technology in early childhood*. New York: Teacher's College Press.

Bers, M. U., Seddighin, S., & Sullivan, A. (2013). Ready for robotics: Bringing together the T and E of STEM in early childhood teacher education. *Journal of Technology and Teacher Education, 21*(3), 355-377.

Betz, D., & Sekaquaptewa, D. (2012). My fair physicist? Feminine math and science role models demotivate young girls. So*cial Psychological and Personality Science. 3*(6), 738-746. https://doi.org/10.1177/1948550612440735

Cheryan, S., Meltzoff, A. N., & Kim, S. (2011). Classrooms matter: The design of virtual classrooms influences gender disparities in computer science classes. *Computers & Education*, *57*(2), 1825-1835. https://doi.org/10.1016/j.compedu.2011.02.004

Corbett, C., & Hill, C. (2015). *Solving the equation: The variables for women's success in engineering and computing.* The American Association of University Women.

Crowley, K., & Jacobs, M. (Eds.). (2002). *Building islands of expertise in everyday family activity.* Mahwah, NJ: Erlbaum.

Cvencek, D., Meltzoff, A. N., & Greenwald, A. G. (2011). Math–gender stereotypes in elementary school children. *Child Development, 82*(3), 766-779. https://doi.org/10.1111/j.1467-8624.2010.01529.x

Dockterman, E. (2014). The war on pink: Goldieblox toys ignite debate over what's good for girls. *Time Magazine*. Retrieved from: http://time.com/3281/goldie-blox-pink-aisle-debate/

Doerschuk, P., Liu, J., & Mann, J. (2007). Pilot summer camps in computing for middle school girls. *ACM SIGCSE Bulletin, 39*(3), 4. https://doi.org/10.1145/1269900.1268789

Drury, B. J., Siy, J. O., & Cheryan, S. (2011). When do female role models benefit women? The importance of differentiating recruitment from retention in STEM. *Psychological Inquiry, 22*(4), 265-269. https://doi.org/10.1080/1047840X.2011.620935

Gal-Ezer, J., & Stephenson, C. (2009). *The current state of computer science in US high schools: A report from two national surveys.* Retrieved from Computer Science Teachers Association website, https://csta.acm.org/Research/sub/Projects/ResearchFiles/StateofCSEDHighSchool.pdf

Hunt, V., Layton, D., & Prince, S. (2015). *Diversity matters*. McKinsey & Company.

Kuhn, D., Nash, S. C., & Brucken, L. (1978). Sex role concepts of two- and three-year-olds. *Child Development, 49*, 445–51. https://doi.org/10.2307/1128709

Lummis, M., & Stevenson, H. W. (1990). Gender differences in beliefs and achievement: A cross-cultural study. *Developmental Psychology, 26*, 254-263. https://doi.org/10.1037/0012-1649.26.2.254

Margolis, J., & Fisher, A. (2002). *Unlocking the clubhouse: Women in computing.* Cambridge, MA: MIT Press.

Metz, S. S. (2007). Attracting the engineering of 2020 today. In R. Burke & M. Mattis (Eds.), *Women and minorities in science, technology, engineering and mathematics: Upping the numbers* (pp. 184-209). Northampton, MA: Edward Elgar Publishing. https://doi.org/10.4337/9781847206879.00018

National Center for Science and Engineering Statistics. (2013). *Women, minorities, and persons with disabilities in science and engineering: 2013*. Special Report NSF 13-304. Arlington, VA. Available at http://www.nsf.gov/statistics/wmpd/

National Center for Women and Technology. (2011). *Women and information technology by the numbers. Fact sheet.* Available at: http://www.ncwit.org/pdf/BytheNumbers09.pdf

National Science Board, (2014). *Science and engineering indicators 2014*. Arlington VA: National Science Foundation (NSB 14-01).

National Science Foundation (2017). *Women, minorities, and persons with disabilities in science and engineering: 2017*. Special Report NSF 17-310. Arlington, VA. Retrieved from: www.nsf.gov/statistics/wmpd/

Nosek, B. A., Smyth, F. L., Sriram, N., Lindner, N. M., Devos, T., Ayala, A., … Greenwald, A. G. (2009). National differences in gender-science stereotypes predict national sex differences in science and math achievement. *Proceedings of the National Academy of Sciences, USA*, 106, 10593-10597. https://doi.org/10.1073/pnas.0809921106

Signorella, M. L., Bigler, R. S., & Liben, L. S. (1993). Developmental differences in children's gender schemata about others: A meta-analytic review. *Development Review, 13*, 147-183. https://doi.org/10.1006/drev.1993.1007

Sinno, S. M., & Killen, M. (2009). Moms at work and dads at home: Children's evaluations of parental roles. *Applied Developmental Science. 13*, 16–29. https://doi.org/10.1080/10888690802606735

Spencer, S. J., Steele, C. M., & Quinn, D. M. (1999). Stereotype threat and women's math performance. *Journal of Experimental Social Psychology, 35*, 4-28. https://doi.org/10.1006/jesp.1998.1373

Spielhagen, F. R. (2008). Having it our way: students speak out on single-sex classes. In F. R. Spielhagen (Ed.), *Debating single-sex education: Separate and equal* (pp. 32–46). Baltimore: Rowan & Littlefield.

Steele, C. M. (1997). A threat in the air: How stereotypes shape intellectual identity and performance. *American Psychologist, 52*, 613– 629. https://doi.org/10.1037/0003-066X.52.6.613

Stout, J. G., Dasgupta, N., Hunsinger, M., & MacManus, M.A. (2011). STEMing the tide: Using ingroup experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology, 100*(2), 255–270. https://doi.org/10.1037/a0021385

Strawhacker, A. L., & Bers, M. U. (2015). "I want my robot to look for food": Comparing children's programming comprehension using tangible, graphical, and hybrid user interfaces. *International Journal of Technology and Design Education, 25*(3), 293-319. https://doi.org/10.1007/s10798-014-9287-7

Strawhacker, A., Sullivan, A., & Bers, M. U. (2013). TUI, GUI, HUI: Is a bimodal interface truly worth the sum of its parts? *Proceedings from IDC '13: The 12th International Conference on Interaction Design and Children.* New York, NY: ACM.

Sullivan, A., Elkin, M., & Bers, M. U. (2015). KIBO robot demo: Engaging young children in programming and engineering. In *Proceedings of the 14th International Conference on Interaction Design and Children (IDC '15*). ACM, Boston, MA, USA.

Zweben, S., & Bizrot, B. (2015). 2014 Taulbee survey. *Computing Research News, 27*(5). Retrieved from https://cra.org/wp-content/uploads/2015/06/2014-Taulbee-Survey.pdf

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