



Parental Interest in Children's Further Exposure to STEM Related Activities after an All-girls Robotics Camp

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Authors' contributions

This work was carried out in collaboration between all authors. Author MK designed the study, submitted the application to the institutional review board, ran the camps, surveyed the parents and co-wrote the first draft. Author DVKB assisted with design of the study, managed the literature searches, co-wrote the first draft of the manuscript, input the data and ran some statistical analysis. Author BC had oversight of the analyses of the study, reviewed and ran some statistical analysis, reviewed several drafts of manuscript and assisted with editing and with the final draft. All authors read and approved the final manuscript.

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ABSTRACT

This pilot study of parental attitudes concerning an all-girls robotics camp was conducted in the summer of 2015 at Saint Leo University, a private, not-for-profit university in the southern United States. The purpose of the research was to determine parental interest in further exposure to STEM related activities after an all-girls robotics camp, and whether parents' own prior exposure to computer programming or confidence with computers may have had some influence. Results indicate parental support for the *Girls Can!* Robotics camp was exceptionally high for almost all areas, especially the social and team oriented aspects, as well as the academic enrichment it

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offered. Parents who reported a higher level of comfort with computers responded more positively concerning their future intentions regarding whether they would encourage their child to engage with additional technology related activities and academic courses than parents who were less comfortable with computers. Parents appeared to strongly support further exposure to technology, but not necessarily to computer programming.

Keywords: Robotics; programming; girls; STEM; technology.

1. INTRODUCTION

Parents are their children's first, and arguably most important, educators; from their parents, children learn how to walk, talk, and explore the wider world around them. They also observe parental attitudes concerning school, and the world of work, as well as various career paths their parents believe are open to them. Explicitly and implicitly, parents send messages to their children concerning what they can be when they grow up, and whether learning as an activity is valued outside of formal educational settings. Parents' participation in and support for their children's educational experiences can reinforce a child's motivation for academic success. By enrolling their child in extra-curricular activities and encouraging wide-ranging and diverse experiences, a parent can engender a love of learning for learning's sake, and broaden a child's knowledge and interest in various career paths. Without parental involvement and active support, girls may not be exposed to as diverse a selection of extra-curricular experiences as their male counterparts. They may also have limited access to female role models, particularly in STEM related fields, which continue to be dominated by white males. Additionally, identification of what is "women's work" versus what is "men's work" has occurred from an early age, resulting in a tendency for girls to opt-out of male-dominated professional fields like chemistry, computer science, and engineering. The stereotyping of certain professional fields as the particular purview of men can be readily found in mainstream culture, and at home. "Male and female ICT workers attributed women's choices not to work in an ICT field but to their socialization at home and in school as opposed to differences in their ability [1]." Indeed, "[g]irls continue to be less likely to take computer programming classes, physics, advanced math, and advanced science classes in high school than boys, and are less likely to select a STEM major in college. This is not a new problem to be grappled with; the divergence of females' and males' interest in STEM programs has been reported over many decades [2]."

The affect parents may have on their child's educational aspirations and career orientation is possibly stronger than any other factor [3] yet there is limited discussion in the research literature on this topic. Exploring parental attitudes towards STEM related activities and their support (or lack thereof) is an important component in determining how to interest more girls in STEM related career paths. According to Ing, "the early influence of parents and the ways they can shape their children's gender development through the types of activities they encourage their children to participate in, such as playing sports or dolls [4]." Girls in particular can benefit from a parent who encourages them to investigate experiences more typically created with boys in mind, such as the *Dangerous Book for Boys* [5], *Grossology* [6], mud runs, and STEM camps and clubs. By encouraging their daughters to think outside the stereotypes found in popular media, which promote Barbies™ and cellphones for girls and airsoft and Xbox™ for boys, and by actively promoting STEM activities, parents can engender genuine feelings of accomplishment and achievement based on work-like activities, fostering a stronger sense of self. However, there is a dearth of information in the research literature regarding parental attitudes towards gender-specific camps focusing on STEM. Investigating parents' previous exposure to computer programming, their own attitudes towards math and science, and experience with STEM may shed some light on how their attitudes may contribute to encouraging or discouraging their child's further exploration. Research that assists with understanding parental attitudes could shift how educators talk about STEM with parents and their children. Further, it could potentially expose gender bias or stereotypes parents might have about their daughters' future career choices. This research could also support the planning process for future camp offerings.

At this juncture in time, there is an aligning of interest and support across many organizations for extracurricular activities such as a robotics camps that can spark an interest in a young

woman, an interest that can potentially lead to a career in a STEM related field. This may be especially important in the middle grades, when career interest is developing at the same time that interest in STEM courses may be waning. An interest in the sciences can be fostered using “activities that clarify and validate vocational self-concepts [7].” This renewed interest in engaging girls in Science, Technology, Engineering, and Math (STEM) has been driven in part by recent reports concerning the continuing disengagement of females in the hard sciences after middle school, and by a growing concern that America is once again lagging behind other nations in math and science. These academic fields have the potential for leading young people into career fields with a lot of potential for future growth. According to the American Association of Women, and based on an analysis of U.S. Census data and U.S. Department of Labor Bureau of Labor Statistics, “In less than 10 years, the United States will need 1.7 million more engineers and computer scientists. Adding women strengthens the talent pool and leads to better creativity, innovation, and productivity [8].” Encouraging all young people to become involved in this growing field is good for the student, for their graduation prospects and for their future ability to think on their feet and analyze the information provided.

Exposure to hands-on activities such as robotics and programming can foster a sense of the real world of work, as students work in collaborative groups to solve concrete problems, which is more closely aligned with how organizations tackle challenges in the workplace. There can also be roles and responsibilities assigned or handled by individual members of the group, another connection to the world of work, and to social networks. Children are also exposed to concepts in computer programming, logic, and circuitry, many (if not most) of them for the first time. This can be especially helpful for middle school girls, as the barrier to entry for women in STEM fields may have as much to do with exposure levels as interest.

While to the casual observer a robotics camp may not seem to be teaching the logic and power of programming, the underlying system which controls the robot is a programmable chip, linked to a hand-held device or a computer. Therein lies the power and beauty of the concept; the children learn how to manipulate and control an object using basic programming concepts and simple programming language, fostering intrinsic

motivation in the programmer to want to learn more in order to advance to the next level. This may also be the only chance for the child to have exposure to programming languages and concepts, as only a small percentage of schools offer computer programming, and even fewer offer robotics courses or clubs. In 2013, the latest date for which information is available, 29,555 students in the United States took the Advanced Placement (AP) computer science exam; 5,485 (18.55%) of those test takers were female [9]. At present, there is no known data-set for compiling information concerning course offerings and clubs at the middle school level, nor is there any information concerning non-AP courses in these subjects. That is very troubling, as not every student interested in computers, computer programming, or robotics is necessarily going to fit the criteria needed to take an Advanced Placement course. Many students become interested and engaged with computers without a formal education, but many more may not have the resources or support of their parents to self-teach computer and programming concepts.

Additionally, many schools do not currently have the funding or the resources for offering robotics courses in the curriculum, as “the focus on high stakes testing topics coupled with increased emphasis on Advance Placement courses has squeezed out coursework in many areas, including computer science [10].” This does not mean that there is a lack of interest in computer science, but there is limited (or no) access to these types of courses in many schools. One way to combat the dearth of core courses and electives in STEM is by offering STEM camps and enrichment programs after school or in the summer, either as stand-alone initiatives at the school level, or in partnership with a community stakeholder, such as a community college or university, or with service organization such as the Boys and Girls Club, Rotary, or the Salvation Army.

Extra-curricular activities such as clubs and camps can generate interest and engage students, which may foster an interest in investigating formal coursework either at the student’s school or online. Attending a robotics camp or participating in after school robotics activities has been shown to have a positive correlation with interest in STEM fields and STEM knowledge, with potentially a “significantly greater impacts for girls than boys [11].” Furthermore, for young women especially, “Robotics programs can help grow spatial

abilities, critical thinking skills, problem-solving abilities, and increase interest in STEM subjects and careers for young people. Studies showed that doing robotics helps girls break through stereotype[d] barriers and provides them an environment to explore STEM [12].” This type of supportive environment may be especially critical for girls thinking of entering computer programming fields, or specializing in game design, or other male-dominated professions.

The intent to offer a girls-only robotics camp crystalized when a colleague shared an invitation for grant proposals to support programs helping young women explore STEM related activities offered by the American Associate of University Women (AAUW). The idea of offering a math camp slowly morphed into a girls’ robotics camp instead. There was clearly a need for high quality educational camps for the children of east Pasco County, Florida; the combination of these ideas together was the inspiration for the project. The researcher was unaware of any STEM camp offerings in a twenty-five mile radius of the University, and when an initial inquiry was sent out to the community to determine interest, the response was very positive.

A large portion of the funding needed to support three one-week sections of the *Girls Can!* summer robotics camps was underwritten by the Saint Leo University, providing an opportunity to explore the feasibility of continuing to offer this and other similar camps in the future; the University provided stipends for three undergraduate student assistants, the camp director, the robotics kits and other supplies, as well as professional training for the camp director.

2. METHODOLOGY

The purpose of the research was to determine parental interest in further exposure to STEM related activities after an all-girls robotics camp, and whether parents’ own prior exposure to computer programming or confidence with computers may have had some influence. Planning and preparation for the camp and the research began approximately nine months prior to the application being filed with the Institutional Review Board of Saint Leo University in May, 2015. After a review of the current research in the professional literature, and after some discussion concerning the need for more information in the professional literature, it was determined to proceed with investigating

attendees’ attitudes during and after the camp using survey methodology, and to also survey the parents at the end of the camp as well, to determine how the parents felt about their child’s camp experience, and whether parents intended to encourage an interest in STEM programs, clubs or other activities for the 2015-2016 school year. The research proposal was reviewed by the Institutional Review Board (IRB), and approved in June, 2015 to conduct survey research with the parents and camp participants.

The survey was constructed using open ended responses, and a likert scale for closed ended questions; this was the first year of offering the camp, and the questionnaire were piloted as part of this research study. The researchers were interested in determining if previous exposure to STEM related activities like programing, or a parent’s confidence with computers would influence parental attitudes, and what parents felt were the best aspects of the girls-only robotics camp, in order for the camp director to review and revise activities as needed to increase parental satisfaction. Participants were asked their opinion about what they considered to be some of the most important aspects of the camp, including team work, making friends, learning computer programming, academic enrichment, etc. Parents were also asked about the likelihood of encouraging their child to further explore STEM related activities in and out of school after the camp’s completion.

Reliability of the subscale which asked parents about the best aspects of the camp was good, with a Cronbach’s Alpha of .574. Parents were also asked about the likelihood of encouraging their child to further explore STEM related activities, such as another robotics camp, a technology club, or a programming class or club at school or outside of school. Reliability of the subscale which asked parents about the likelihood of encouraging their child to further explore STEM related activities was also good, with a Cronbach’s Alpha of .511. Cronbach’s Alpha is a measure of scale reliability; it measures internal consistency of grouped items, and how closely related they might be [13]. Convenience sampling was used, with all registered campers and one parent/guardian of each camper being asked to participate. All sixty registered camp attendees assented to participate; however, the one child’s responses were excluded from data analysis as she was related to one of the researchers. Parents were also asked to consent to their child’s

participation, and their own participation. Data collected was analyzed using SPSS v22 descriptive statistics tools, primarily frequency tables.

Fifty-one parent/guardians were asked to complete the post-camp survey; thirty-five completed and returned it within one week of each camp's completion, for a return rate of sixty-eight percent per household. If a parent/guardian had more than one camper attending the camp, they were asked to complete a post camp survey for each camper. Some demographic information was also collected when campers were registered.

3. RESULTS AND DISCUSSION

Overall, the response to the camp was very positive, with ninety percent of respondents indicating they were very likely to enroll their child in a robotics camp again; however, when asked more specifically as to whether they had any immediate plans for encouraging their child to get involved with computer programming, forty-two percent either had no plans to stay involved, or were unsure. When asked if they would try to get their child involved with robotics after the camp, sixty-three percent of respondents indicated they would do so, while thirty-one percent of respondents were not sure, and a small minority (3%) indicated they had no plans to enroll their child in another robotics activity.

Additionally, while parents clearly saw a benefit to exposing their children to robotics, they were not as willing to encourage their child to explore computer programming. This was an interesting development, as fifty-four percent of the parents who responded to the post camp survey indicated they had tried computer programming themselves, and seventy-four percent indicated they had a lot of confidence when working with computers, which would seem to be a good background for encouraging their daughters to become more interested in computer programming. Fisher's Exact Test (Table 1) was performed using SPSS 22. The Fisher's Exact Test procedure calculates a probability value for the relationship between dichotomous variables when sample sizes are small.

Parents who reported a higher level of comfort with computers responded more positively concerning their future intentions as to whether they would encourage their child to engage with

additional technology related activities and courses than parents who indicated that they were less comfortable with computers. Interestingly, it did not appear to matter, at least for the respondents in this study, whether the parents had themselves' been exposed to computer programming or were confident in their own abilities with computers. Caution in this area may be indicated, however, as the P values were small ($P = .12$) and ($P = .16$), respectively, and this was a pilot study of the first year of the camp; the data set was also small ($N=60$). Support for additional exposure to technology in general appeared to be strong among the respondents; however, whether there was parental support for fostering an interest in computer programming and other computer-related activities was less clear. Further research with a larger sample may be needed to determine whether this is indeed the case. It would also be of value to conduct interviews with parents to ascertain the attitudes of the parents concerning their own previous exposure to computer programming, and whether their child's experiences at robotics camp influenced their perspective in any way. It would also be interesting to interview the children to determine whether the parents have indicated any gender specific expectations to their daughter about STEM careers.

Fisher's Exact Test was also performed to determine if there could potentially be a connection between the parent's previous reported exposure to programming and the parent's interest in exposing their child to additional technology-related opportunities after the camp's conclusion (Table 2). The P values were not small enough to be significant ($P = .311$), based on this dataset.

The number of respondents who indicated they had been exposed to computer programming was fairly evenly split between parents who had had exposure to computer programming and were likely to enroll their child in another technology related activity, and those parents who indicated they had not been exposed to computer programming, but were still likely to enroll their child in a technology club, class, or program.

These findings used a very small set of respondents, and therefore no conclusions can be made as to generalizability or whether there is or is not a connection between parental exposure to computer programming, parental confidence when using a computer, and their willingness to

encourage their daughter to explore additional STEM related activities. In fact, the findings are interesting because they raise the question of whether the exposure to STEM related activities should also include a parent when possible. Why should one think that including parents might be important? As Notter [14] noted from her focus group research on methods to engage girls in STEM, parents may not have a clear idea of what one might be able to do in a STEM related career, and are therefore perhaps unable to provide feedback and support for choosing a career in a STEM related field. "It's exciting just to expose them but quite honestly, I feel like I don't even know sometimes how to even direct that exposure um because I, I, you know when you were asking about what kind of field they would go into and everything, I wouldn't even know what to tell her. What do you do with robotics?" She further noted, "The only connection they made to STEM fields was programming, none of the other careers options were acknowledged [15]." This lack of information concerning STEM related careers has been noted, and there are a few efforts underway to include and inform parents. For example, the 2015 K-12 STEM Symposium aimed to educate students, teachers, and business leaders about the importance of parent involvement. "Whether a child is interested in computer coding or chemistry, or has yet to show

an interest in STEM, parents need actionable information to spark and motivate their children." [16] To this end, the 2015 K-12 STEM Symposium provided each attendee with "a Parent-STEM action plan geared towards nurturing a child's curiosity towards the STEM fields" [17].

Further research is needed in order to explore the question. Additional research into whether feedback provided to parents by their children during the week of the camp may also expose other reasons for interest in further pursuit of STEM activities. More exploration into parents' motivation for enrolling their child into the camp in the first place is also warranted, as it is unclear whether or not parents' previous exposure to robotics, computer programming, or a family interest in tech-related activities, might have increased the likelihood of enrollment in other activities, post-camp.

Results also indicated that at least some of the motivation for enrolling a child might be due to an interest in widening their child's social circle or improving the child's interpersonal skills. Sixty-eight percent of parents indicated in the post-camp survey that their child had made new friends, and ninety-seven percent indicated their child enjoyed building robots. Eighty-five percent of parents did indicate they believed their child

Table 1. Fisher's exact test, level of comfort with computers and future intentions

	Chi-square tests				
	Value	Df	Asymp. sig. (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Pearson Chi-square	2.378 ^a	1	.123		
Continuity correction ^b	1.398	1	.237		
Likelihood ratio	2.466	1	.116		
Fisher's exact test				.163	.118
N of valid cases	35				

a. 0 cells (0.0%) have expected count less than 5. The minimum expected count is 5.14

b. Computed only for a 2x2 table

Table 2. Chi-square tests, exposure to programming and interest in additional tech opportunities

	Chi-square tests				
	Value	df	Asymp. sig. (2-sided)	Exact sig. (2-sided)	Exact sig. (1-sided)
Continuity correction ^b	.277	1	.599		
Likelihood ratio	1.101	1	.294		
Fisher's exact test				.640	.311
N of valid cases	35				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is 2.06.

b. Computed only for a 2x2 table

had learned some programming, but the question on programming was less clear as to whether the children enjoyed learning the programming. One parent provided partial insight, by stating on the written comments that the child “loved it, but it also helped her determine she would not work with computers later in life.” However, another parent responded in this manner: “I think this camp gave her an opportunity to learn more of the programming aspect... liking those things opens up so many more possibilities, in college and beyond” (Kiss, Van Kampen-Breit, Camp, Saint Leo University, USA, raw data). Therefore, it is somewhat difficult at this time to determine if the girls themselves were more enthusiastic about the creativity of the robotic camp activities and the social aspects, or if they also were interested and engaged by the computer programming. This is an area that will need further investigating.

The educational aspects of the camp appeared to be a large motivation for the parents to enroll their child in the camp. Thirty-nine percent of parents indicated they encouraged their child to enroll, while fifty-seven percent indicated their child had expressed an interest in the camp, either due to the robotics, or science. As this was definitely an academically oriented day camp, it was very encouraging to note the interest of both the campers and their parents. When asked to fill-in-the-blank concerning their child's favorite subject on the post camp survey, sixty-three percent of respondents indicated their child's favorite subject was math or science, while music, reading, writing and art each had low responses, with less than three responses for each of these academic areas.

Other aspects of the camp that parents were very interested in were the creative and social components of the camp. While the post-camp survey did not specifically ask parents whether their child had difficulty making new friends, the responses indicate parents were interested in their child's social life and her ability to increase her social circle. Sixty-eight percent of parents responded that one of the best things about the camp was that their child made new friends, while seventy-four percent were happy their child got out of the house and had fun. They also appreciated the creative aspects of the camp, with eighty-five percent indicating one of the best aspects of the camp was the creativity. Middle school can be a time of transition for many children; further exploration of these aspects and their perceived importance may be warranted.

4. CONCLUSION

Parents are their children's first, and usually most important, educators. Tomorrow's workforce needs to be tech savvy and literate in STEM fields in order to meet the labor force needs of the 21st century economy. Students need to be comfortable with tech at an earlier age than previous generations, and able to work in teams as well as individually. Engaging and interesting Parents in STEM exposure is critical for garnering increased parent support of their children's exposure to STEM courses and activities, especially for girls, who have traditionally steered away from the hard sciences.

Parental support for the *Girls Can! Robotics* camp was exceptionally high for almost all areas, especially the social and team oriented aspects, as well as the academic enrichment it offered. Robotics brings to life elements of engineering and computer programming which might at times come across as dry and lifeless in a traditional learning environment. Hands-on experience is known to engage students on a deeper level, and working in paired teams can add another social dimension to the camp.

Whether there was support for continuing to foster their child's interest in computer programming was less clear. When planning a robotics camp it would be wise to include activities that not only support academic enrichment but also contain a clear social component. It follows that this approach will attract more participants, especially among parents who wish to broaden their child's social circle or enrich their child's interpersonal skills. Girls can be encouraged to participate in STEM related activities if parental involvement is encouraged, and if a collaborative approach is emphasized as part of the program. Incorporating ice-breakers and social components to encourage team building, including a parent-child activity as part of the camp, could increase parent involvement and interest in supporting their child's forays into what might seem like unknown territory. If a child is hesitant to participate, or if the parent is hesitant to enroll their child due to their own lack of exposure, incorporating early engagement strategies such as a “family night” or a Mom/Dad and Me day could increase some children's interest, and increase parent engagement.

Interestingly, there may be a connection between the parent's intent to further support the child's interest in extra-curricular technology related activities and whether the parent has confidence in their own skills concerning computers. The decision as to whether to continue to pursue other opportunities for robotics, computer programming or other STEM related activities for their daughters might (although not supported in this small study) also be slightly influenced by whether the parents themselves had previously been exposed to computer programming, or it could have been as a result of informal feedback obtained from their children at the end of each camp day. Further investigation would be needed to determine if any of these factors might affect parental interest and intent. Additionally, future research studies should focus on parental interest in their children's further exposure to STEM related activities, particularly as it pertains to girls, and all-girls robotics camps.

The authors of this paper are interested in learning of other institutions' research efforts in this area, and exploring collaborative research, whether by sharing of information on best practices, collecting data from camps using a revised version of the forms developed for this purpose, or by listening to the experiences of others. The researchers also believe that all-girls STEM camps can be used as long-term recruitment opportunities for any college or university whose mission includes recruiting minorities into STEM programs, and supporting non-traditional students in STEM fields; everyone benefits from this early relationship.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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