

Exploring Student Perceptions of Teamwork in a Summer Outreach Program

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Abstract

Increasing numbers of summer outreach programs aim to engage students in science, technology, engineering and mathematics (STEM). A common approach to these programs is project-based learning (PBL), which often involves working in teams. Ideally, students participating in these programs work together in teams to apply the STEM knowledge gained from their program experiences; these intentional communication and collaboration experiences are also likely to enhance students' teamwork skills. However, team experiences are not always positive, and some team members may not feel welcome to contribute. Team experiences can negatively affect students' sense of belonging and their motivation to continue pursuing STEM. Accordingly, the purpose of this study is to examine team experiences based on gender, which previous research suggests may impact a student's experience. To address this purpose, we utilize survey data from the summer of 2018 to investigate the perceptions of the students who participated in SEEK (or Summer Engineering Experience for Kids), a summer outreach program offered by the National Society of Black Engineers (NSBE). Results will advance understanding of teaming experiences in STEM outreach contexts, enabling educators to improve these experiences for everyone.

Introduction

Summer outreach programs provide a platform for broadening participation in STEM (Byars-Winston, 2014). These out-of-school programs have received both private and federal support to improve the educational and career development of diverse individuals to work in STEM fields (Educate to Innovate, n. d.). Academic institutions and other organizations, such as the National Society of Black Engineers (NSBE), point to outreach programs as a critical component to raise STEM interest (Jeffers, Safferman, & Safferman, 2004). Many of these summer STEM programs reflect the general principles for K-12 engineering education (Committee on K-12 Engineering Education in the United States, 2009) to include an emphasis on engineering design, STEM knowledge, and teamwork skills. Project-based learning (PBL) strategies implemented in STEM outreach programs promote collaborative engagement and teamwork skills (Huang, 2010). Research states that when students work together to support their common project goal, the intentional communication and collaboration improves their teamwork skills (Kolmos & De Graaff, 2014). Recognizing the benefits of engagement and team work skills, STEM outreach programs such as NSBE's SEEK program use the PBL approach in their programs.

Overview of SEEK

Since 2007, over 20,000 children from groups considered underrepresented in STEM have participated in NSBE's SEEK program. The SEEK program is a three-week summer engineering program for 3rd-5th grade children from underserved communities in cities throughout the country. The overarching purpose of the program is to provide opportunities to increase SEEK students' engagement in and knowledge of engineering and other STEM fields. In addition, SEEK encourages growth in students' critical thinking and teamwork skills through hands-on PBL activities where mentors and student teams work on projects for weekly competition events. SEEK currently operates at 16 sites throughout the nation, strategically selecting locations to

serve traditionally underserved students (Edwards, Lee, Knight, & Fetcher, 2018) in STEM with each site serving 75-300 students. SEEK established 14 of the 16 sites as co-ed camps, and created two all-girl sites, enabling the study of the teamwork skills within mixed gender and female only teams. The curriculum is designed to provide engineering experiences and includes topic-based projects. Students work through three modules, out of the 12 curricula offered, during the program three-week duration. Each week they construct a working model aligned with the curriculum module for the end-of-week competition to test their ability to integrate concepts they learned during the week. These modules include teamwork efforts of communication and collaboration. SEEK works to achieve their objectives and broaden participation in order to inspire a more diverse STEM talent pool not only by focusing on underrepresented groups, but by also selecting racially similar mentors to student participants to serve as role models, encouraging parental involvement, and hosting their programs in communities that are near their targeting groups (Edwards C. D., et al., 2018).

Purpose

The purpose of this quantitative analysis is to investigate variation in self-perceptions of life skills as well as reports of team processes across 3rd-5th grade SEEK students as a function of gender. Our study will answer the following research questions:

How do SEEK girls and boys differ in their self-perceptions of life skills and reports of teamwork processes?

How do SEEK girls and boys differ in their self-perceptions of life skills and reports of teamwork processes as a function of the camp's gender structure (i.e., co-ed versus all-girl)?

Literature Review

The benefits of group work (i.e., engagement, teamwork skills, deeper learning) are maximized for individuals when they perceive themselves to be valued members of the team (Sage, Vandagriff, & Schmidt, 2018). For example, in a study of student perception of group dynamics, those who were comfortable in their group showed an increase in content mastery by over 27% (Theobald, Eddy, Grunspan, Wiggins, & Crowe, 2017). However, not all teams work cooperatively (Johnson & Johnson, 1999). Students may lack group behavior skills and become frustrated when working with teammates (Achilles & Hoover, 1996). Additionally, students can often feel uncomfortable contributing within groups, and these experiences can negatively affect their perceptions of their ability to be an effective team member (Lichtenstein, G., Chen, Smith, & Maldonado, 2014). A study by Sage et al. reported that students who did not feel included or involved in their group engaged less because they felt their ideas were not accepted and did not have tasks to complete (2018, p. 29). Thus, the potential benefits of engaging in group work (Smith, Sheppard, Johnson, & Johnson, 2005) can often go unrealized by students who have negative team experiences due to their sense of not belonging with the group (Osterman, 2000; Goodenow & Grady, 1993; Willms, 2003).

SEEK efforts to organize groups by gender provided insights into team and social dynamics, specifically the role girls played in both mixed gender groups, as well as female only teams. Prior research related to single sex and co-ed learning environments offer a lens to further explore perceptions of group work and team experiences (AAUW, 1998; Smyth, 2010; Riordan,

2015; Fletcher, 2017). Intentional grouping of students within a team to include at least two females in each group has been associated with increased student perceptions of belonging and engagement within the team (Michaelsen & Sweet, 2008; Theobald, Eddy, Grunspan, Wiggins, & Crowe, 2017). Additionally, for elementary students, Portsmouth & Swenson (2012) observed that majority girl groups (as well as evenly mixed co-ed groups) share workload and leaderships abilities more equally when working on hands on STEM projects compared to majority boy groups. These findings show that gender composition of groups can have positive implications on perceptions of teamwork skills.

However, studies have found that girls, while often disproportionately represented in STEM programs, also share disparate experiences as the male members of their teams (Tonso, 1996; Hirshfield & Koretsky, 2017; Inzlicht & Ben-Zeev, 2000). Frequently accepting the more gender stereotyped roles of note-taker and task manager, female team members participation is more periphery and under-contributing to the STEM-related component of the team project, as male members typically assume these tasks (Seron, 2016). SEEK single-sex and co-ed camps are positioned to reduce these challenges by offering girl participants more opportunities to directly contribute to STEM related components of the project.

Prior research has provided insight into girls' attitudes towards STEM and methods for encouraging their persistence (Microsoft, 2018; Mosatche, Matloff-Nieves, Kekelis, & Lawner, 2013; Dasgupta & Stout, 2014; McGrath, 2004, Hughes, 2013, Seron, 2016). Although the studies identified the need to improve self-efficacy and a sense of belonging with efforts such as providing female role models and opportunities for teamwork, these studies did not address girls' perception of belonging in STEM teamwork activities. SEEK insights suggest different perceptions exist between girls and boys within teams during STEM exercises.

Research Methods

In partnership with the NSBE team and supported by an award from the National Science Foundation (NSF), researchers at Virginia Tech and Purdue University designed and implemented a study focused on researching the effectiveness of SEEK and studying its organizational features. Pre- and post-tests were administered at each site on the first and next-to-last day of the program in paper and pencil format, collecting data on students' math, science and problem solving, and engineering conceptual knowledge skills, attitudes toward math and science, life skills, academic motivation, reports of team processes, and interests in and perceptions of engineering. Additionally, the research team collected background information and parental consent of their minor's participation in the study. Although 1,125 students completed the assessment, the IRB consented data reported in our analyses only includes 847 participants who provided consent.

This paper focuses on the survey components related to life skills and report of team processes. To measure Communication Skills and Group Work Skills, we leveraged Robinson and Zajicek's (2005) Youth Life Skills (YLS) Inventory, which was adapted from the Leadership Skills Inventory (Townsend & Carter, 2003) to be applicable for measuring skills of students who are in grades 3–5. The following table, Table 1, lists the questions that were asked of all the students with response options of either no (1), maybe (2), or yes (3); or never (1), sometimes (2), always (3).

Scores for questions 1, 6, 8, and 9 were averaged to derive the Communication Skills scale, and scores for questions 2, 3, 4, 5 and 7 were averaged to derive the Group Work Skills scale. Additionally, questions 10 through 15 capture student’s perceptions regarding their team process experiences with response option of never (1), sometimes (2), or always (3).

To address our research questions, we compared means of students grouped into three categories: girls at co-ed sites, boys at co-ed sites, and girls at all-girls sites. We ran independent samples *t*-tests to investigate statistical significance of differences across means. Although we are unable to report findings, we did complete analyses on the full sample as well as the IRB-approved sample, and results were consistent.

Table 1: SEEK Survey Questions for Youth Life Skills and Team Processes

#	Questions	Scale
1	I am a good listener.	Communication Skills
6	I am good at following directions.	
8	When I say something, people understand me.	
9	When other people want to say something, I listened to what they want to say.	
2	I can work with other people.	Group Work Skills
3	I can work well in a group.	
4	I think that all people in a group should help in doing a job.	
5	When I am in a group, I do what I am supposed to do.	
7	I think what other people want to say is important.	
10	My teammates shared ideas and answers with one another.	Team process experiences
11	I asked my teammates questions when I didn’t understand something.	
12	My teammates helped each other understand when we had problems.	
13	My teammates made people feel comfortable working in the group.	
14	My teammates stayed on the assigned task.	
15	My teammates tried to find out why when we did not agree with one another.	

Results

Figure 1 reflects the responses regarding the YLS Inventory questions, which captured Communication Skills and Group Work Skills. Universally, students rated themselves positively on these measures, with averages ranging from 2.59–2.80. However, boys rated both their communication and their group work skills lower than girls. There were not significant differences in girls’ perceptions of their communication and group work skills between the co-ed and the all-girl program participants. Comparing across the life skills, the girls and the boys all perceived their group work skills more positively than their communication skills.

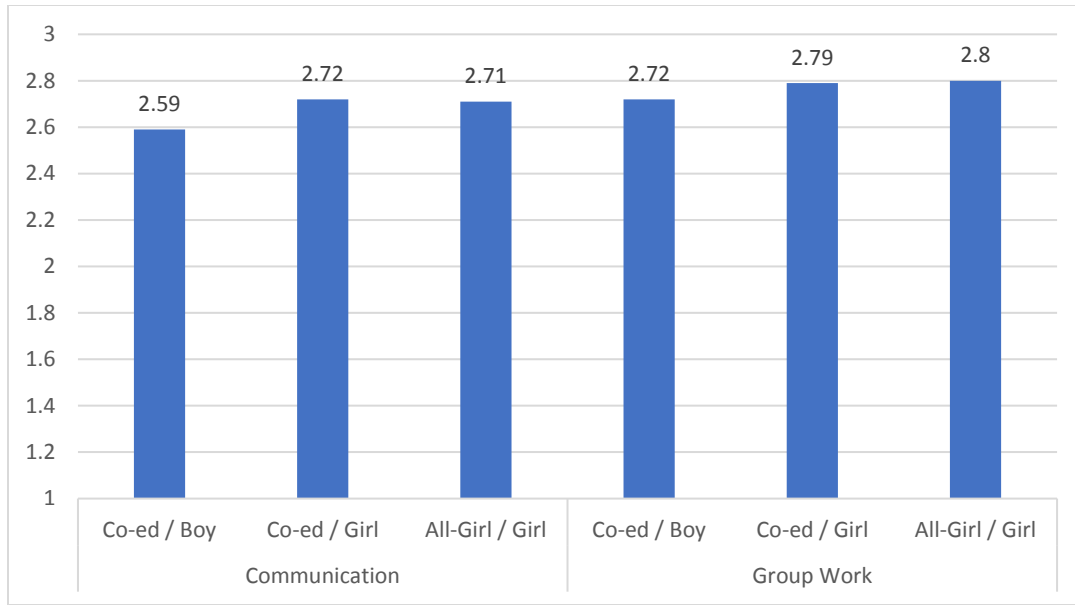


Figure 1: Youth Life Skills of Communication and Group Work

Figure 2 reflect the responses regarding Team Processes. Across all the team process questions, the girls in the all-girls programs rated their team processes higher than both the boys and girls in the co-ed programs. All groups responded most positively to Sharing Ideas (Question 10) and Helping Others (Question 12). Their least positive team process was trying to work out an understanding when they did not agree with one another (Question 15); additionally, the boys also had their lowest positive response for asking their teams questions when they did not understand something (Question 11). The team processes that were experienced the most differently between boys and girls in the co-ed programs were their perception of staying on task (Question 14) and their attempts to find out why when they did not agree with one another (Question 15). The boys perceived both processes more positively than the girls did. The girls in co-ed programs did not perceive their team attempted to find out why when they did not agree with one another as positively as the boys in the co-ed programs.

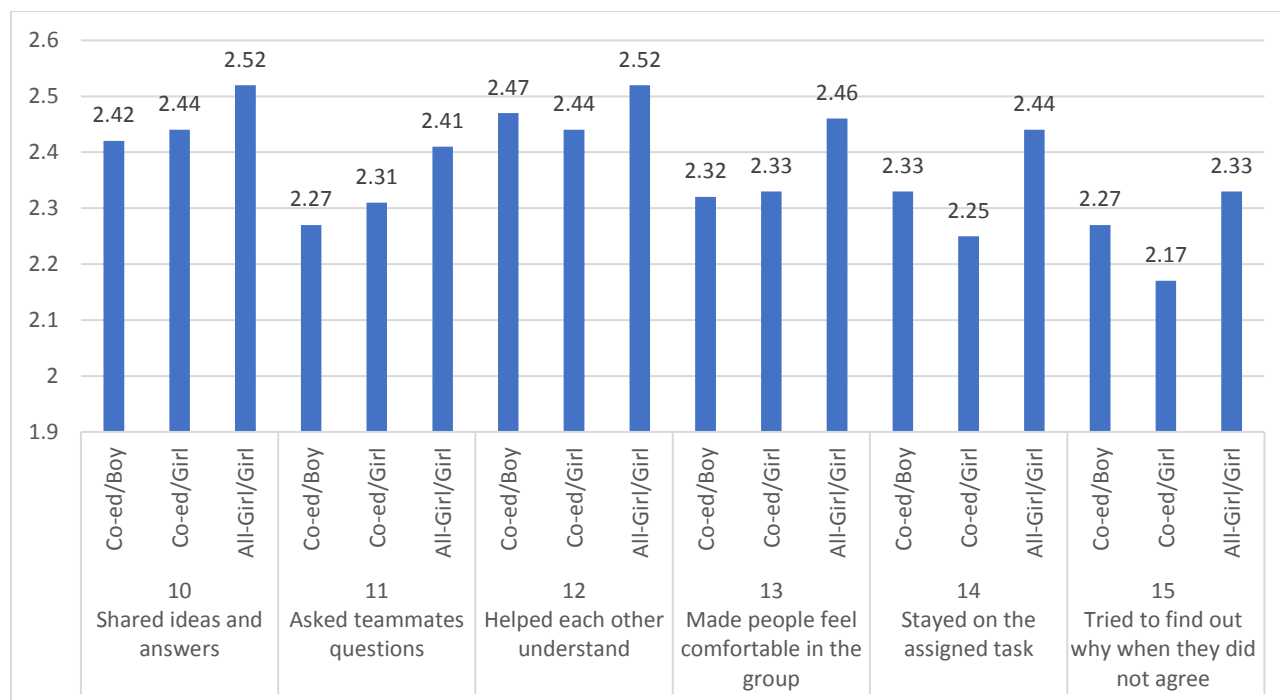


Figure 2: Team Processes

Discussion

The life skills survey questions focused on self-evaluation perceptions by the participants, grouped into communication or group work categories. A clear variance exists within the co-ed group between boys and girls, with the girls self-assessing more positively as a group than the boys. This variance does not align with prior studies of gender grouping (Hughes, 2013, Taylor, 2019), which did not find benefits of all girl camps or teams in development of STEM identity. However, these earlier studies did not include a survey of the girl participants' perception of their group work skills. Nevertheless, the communication and group work skills self-assessments showed consistency for the girls, regardless of group composition. This may suggest that girls value communication and group work skills, which supports earlier studies that assert girls seek and use collaborative learning strategies more than boys (Stump et al., 2011).

This consistency did not exist among the female groups when answering the team process questions. From this outlook, there was a notable inconsistency based upon group constitution. In all areas, the girls in the all-girl programs perceived their team processes more positively than the girls integrated into the co-ed programs. While the co-ed programs included both boys and girls, the distribution was not evenly split between the genders; the boy versus girl ratio was roughly 2 boys for each girl (37% girls). Within co-ed groupings, the girls represented the minority membership of these groups. Their less positive perception, compared to the all-girl participants perception of team processes could support the prior studies that found less engagement of team members who did not feel as if they were an accepted member of the team (Osterman, 2000; Goodenow & Grady, 1993; Willms, 2003).

Conclusion

Summer STEM outreach programs such as SEEK, which use team-based PBL approaches to engage students, provide opportunities for students to increase understanding and enjoyment of studies within the areas of math and science. The findings of this study show that girls' perceptions differed from boys in the co-ed programs, girls and boys did not experience the team processes similarly, and the variations were not consistently positive or negative. Additionally, the girls in co-ed programs perceived team processes less positively than the girls in the single-gender programs. Continued research will attempt to explain the differences by looking at other variables. Nonetheless, the structure of the experience seems to matter for how students experience teamwork efforts and as the literature suggests, this could differentially influence learning, self-efficacy, and continued STEM interest.

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Appendix A

Youth Life Skills	Camp / Gender	N	Mean	Std. Deviation
Communication	Co-ed / Boy	434	2.59	.42
	Co-ed / Girl	258	2.72	.31
	All-Girl / Girl	166	2.71	.35
Group Work	Co-ed / Boy	434	2.72	.34
	Co-ed / Girl	258	2.79	.30
	All-Girl / Girl	166	2.80	.32

Youth Life Skills Survey Responses

Team Processes	Camp / Gender	N	Mean	Std. Deviation
TP1	Co-ed / Boy	429	2.42	.60
	Co-ed / Girl	256	2.44	.60
	All-Girl / Girl	167	2.52	.53
TP2	Co-ed / Boy	429	2.27	.74
	Co-ed / Girl	256	2.31	.70
	All-Girl / Girl	164	2.41	.69
TP3	Co-ed / Boy	423	2.47	.67
	Co-ed / Girl	255	2.44	.66
	All-Girl / Girl	166	2.52	.62
TP4	Co-ed / Boy	428	2.32	.71
	Co-ed / Girl	251	2.33	.68
	All-Girl / Girl	167	2.46	.66
TP5	Co-ed / Boy	424	2.33	.66
	Co-ed / Girl	251	2.25	.63
	All-Girl / Girl	167	2.44	.59
TP6	Co-ed / Boy	431	2.27	.75
	Co-ed / Girl	256	2.17	.76
	All-Girl / Girl	165	2.33	.72

Team Process Survey Responses