

Tiny Houses – Big Learning: Impact of building industry summer camp on middle grade females

Katie Loughmiller, Derek Clements, and Stacy Harris

¹ Kansas State University, Manhattan, KS, United States

² Kansas State University, Manhattan, KS, United States

³ Susan B. Anthony Middle grade, Manhattan, KS, United States

loughmil@ksu.edu

Abstract

Exposure to STEM related careers in K-12 has increased, while the presence of females in building industry related careers has only seen moderate growth over the past several decades. Existing research has identified that exposure to STEM fields in K-12 education can have a positive impact on future career choices. The goal of this research was to explore how perceptions of middle grade female students were impacted by exposure to the AEC field through a summer camp experience. The students participated in weeklong STEM summer institute sessions hosted by a university in which students were given the opportunity to choose from a variety of session topics. This research will focus on the experiences of the students that selected the “Tiny Houses, Big Learning” session. In this session students were exposed to the different stages of the building process through the lens of a tiny house. This included activities related to architectural design, engineering, and construction processes. Students were provided the opportunity to interact with an architectural engineer and a construction manager at different times during the four-day session. Pre- and post-surveys were conducted to analyze the impact of the session on the perceptions of the female students. The surveys asked the students to self-report on their knowledge of the building industry, their interest in how buildings are built, and their interest level in a career in architecture, engineering or construction. The results of the pre- and post-survey results indicated that the female students indicated a neutral or positive increase in their knowledge and interest in the building industry and a positive increase in their interest in engineering or construction related careers.

Keywords

Female, Women, Construction Careers, Construction Education, Engineering Careers, Engineering Education.

1. Introduction

The construction industry has historically been a male-dominated sector; employment of women has risen slightly from 9.1% in 2016 (BLS, 2017) to 11.1% in 2022 (Gallagher, 2022). Although this represents a modest increase, the industry is still significantly lagging behind the overall population distribution. Over the past decade, research has shown that exposure to STEM and specifically construction education in grades 6-12 can provide opportunities for females to learn about these fields. Multiple studies have been conducted focusing specifically on exposing female high school students to construction careers (Mohany, M., et al, 2019, Escamilla & Ostadalimakhmalbaf, 2017). Additionally, research has shown that exposure to problem solving experiences (Cooper & Heaverlo, 2013) and hands-on learning (Haight, 2012) can also impact interest in STEM fields.

The aim of this research was to determine if the summer camp program increased interest in the building industry. When formulating a plan for the summer camp content, a focus on engaging female students was a priority. Middle grade students, specifically in grades five and six were selected as participants based on research indicating that interest in non-gendered careers peaks in middle grades (Lawson, et al, 2018). Existing research had identified that females pursuing a construction management bachelor’s degree showed interest in hobbies that include art,

crafts, and travel (Loughmiller, Keen, & Benton, 2018). Using this information and anecdotal data collected from conversations with a small group of middle grade females, the camp session was designed around tiny house living. By incorporating a topic within the building industry that was attractive to females, students would make a deeper connection with the content (Noddings & Witherell, 1991).

2. Methodology

This research is embedded within a program at xxx that encourages K-12 educators to partner with science, technology, engineering, and math (STEM) faculty to provide summer camp programming for local middle grade students, through a program called STEM Institute. The program was open to male and female students in grades five through eight, with sessions broken down by grades five and six, and grades seven and eight. The authors of this paper developed a camp session titled, “Tiny Houses / Big Learning” that would be available for grades five and six. As previously discussed, the tiny house concept tied directly to the hobbies identified as connecting with female construction management students. The camp session consisted of four days, with a three-hour session each day. Camp sessions were instructed by a female eighth grade science teacher, a female university construction management faculty member, and two students pursuing their education degree. Sessions were limited to a maximum of 15 students.

2.1 Camp Session Schedule

On the first day, the students were introduced to the basics of designing and constructing a tiny house. This included video examples of the design and construction of various types of tiny houses and a brief introduction to the sustainable aspects of tiny houses. After the introduction, the students were presented with the overall project for the camp, designing a tiny house and constructing a scale model. The students were given a list of minimum requirements and a list of design and construction challenges. The challenges included different methods of incorporating sustainability into their tiny houses. The challenges were also presented as opportunities to win prizes at the end of camp.

The students would then move outdoors for an interactive activity. The students were separated into small groups and asked to tape out on the ground the actual dimensions of the tiny house they would be designing; a seven feet by twelve feet space. Once the space was defined, the groups were asked to brainstorm ideas of what to incorporate into their tiny house and draw the elements in chalk. All of the groups shared their ideas and discussed what challenges might have been created with their ideas.

To close out the first day, the students began brainstorming their tiny house design. As a part of the design process, students were asked to develop a construction budget. The budgets were developed using a combination of pricing provided to them and information they were able to gather from a variety of material purchasing websites. This stage of the process incorporated a quick refresh of basic geometry to facilitate the quantity takeoff necessary for the budgeting process.

At the beginning of the second day, students were tasked with completing their hand-drawn design and construction budget. Once those tasks were completed, the students were given access to the iPad application, KeyPlan 3D, and provided a brief tutorial on how to use the application. After completing the KeyPlan tutorial, students were asked to create a digital 3-D model of their tiny house. Students were able to expand on the design choices they made on their hand-drawn design and make adjustments to their construction budget. During the 3-D design phase, the students were asked to incorporate the challenges that were presented on day one.

The second half of this day was dedicated to a guest speaker. An architectural engineering faculty member joined the camp to share how solar power works. The students were able to interact with a solar panel, led lighting, batteries and a power inverter. One of the tiny house challenges presented on day one was to incorporate solar power, so students were able to learn which components would be required when using solar power in their tiny house design.

To start off the third day, students participated in a tool demonstration. Students were provided with safety glasses and gloves and trained on the proper use of a power saw, power drill, and a variety of hand tools. Most of the students had never had the opportunity to use the tools previously, so this provided an opportunity to expose them to carpentry. In the process of learning how to use these tools, the students constructed a scale-sized model of a table for use in their tiny house models.

The remainder of the day focused primarily on the students creating the physical 3-D models of their tiny house designs. The models were built at a scale of 1:12. Students were provided with a variety of materials, including several thicknesses of cardboard, foam, paper, fabric, and adhesives. In this phase of the camp, students were encouraged to incorporate their own personalities into the tiny houses.

The first half of the final day consisted of the students finishing the construction of their scale models. Once the model construction was completed, the group conducted a charette. Students rotated through the group presenting their completed tiny house, sharing their ideas and what challenges they attempted. The final activity of the day was the presentation of the challenge winners. Throughout the four days of the camp, the instructors discussed career opportunities in the building industry, including architecture, architectural engineering, civil engineering, and construction management.

2.2 Survey Methodology

To achieve the goals of this study, a quantitative methodology using pre- and post-surveys was conducted via Qualtrics. The pre- and post-surveys used the same group of questions. The first section of each survey addressed demographic questions of gender, age, and ethnicity. The second section consisted of the following questions:

- How knowledgeable are you about the building industry?
- How interested are you in how buildings are built?
- Would you consider a career in architecture?
- Would you consider a career in engineering?
- Would you consider a career in construction management?

3. Results

During the course of three sessions of the camp, a total of 36 students participated. Of those that participated in the camp, 10 participated in the survey process. The limited survey participation was directly impacted by the requirement for parent consent to participate. The pre-survey was conducted at the beginning of the first session of camp, prior to the introduction of content related to building industries. The post-survey was completed on the last day of camp, prior to the students leaving at the end of the session.

Data collected from the second section of the surveys were collected using a visual Likert scale. For the first two questions, related to knowledge and interest in the building industry, the scale provided was the Qualtrics visual scale “building blocks”, where 1 block indicates the lowest level and five blocks indicates the highest level. For the last three questions, related to careers, the Qualtrics visual scale “smile” was used, where the lowest level is indicated by a frown and the highest level by a smile.

Of the 10 participants, five indicated male as their gender and five indicated female. The ages of participants ranged from 11-12, which was to be expected based on the grade levels associated with participation. The ethnicity of the group identified as 90% white and 10% African American. Although the group was primarily white, this demographic breakdown does match with the community that participants were drawn from (U.S. Census Bureau, 2022).

Question 1, How knowledgeable are you about the construction industry, resulted in a mean of 3.00 for females, and 3.6 for males on the pre-survey. The post-survey results were a mean of 4.00 for the females, and 3.80 for the males (see figure 1). The results show a more significant change in self-reported knowledge about the construction industry by the females than the males.

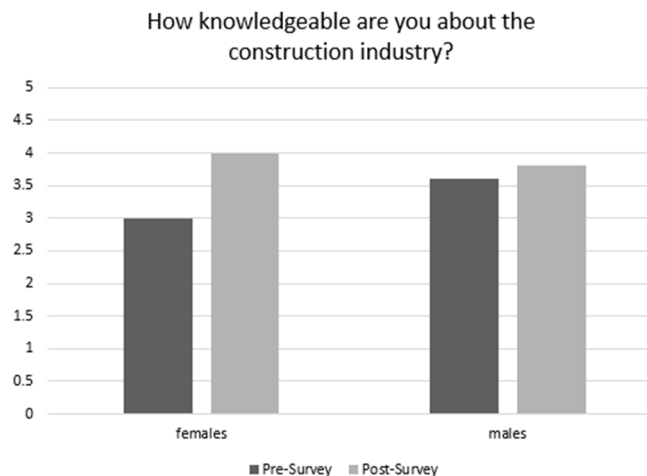


Fig. 1 Participant responses (mean) to Question 1: How knowledgeable are you about the construction industry?

Question 2, How interested are you in how buildings are built, resulted in a mean of 3.80 for females and 3.00 for males on the pre-survey. The post-survey results were a mean of 4.00 for the females and a 3.2 for the males (see figure 2). Similar to question one, the female responses showed a greater change in interest from pre- to post-survey than the males.

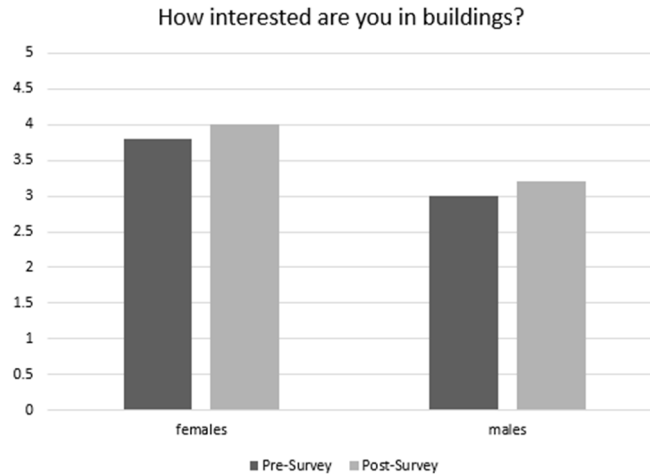


Fig. 2 Participant responses (mean) to Question 2: How interested are you in buildings?

Question 3, would you consider a career in architecture, resulted in a mean of 3.80 for females and 3.20 for males on the pre-survey. The post-survey results were a mean of 3.80 for the females and 3.80 for the males (see figure 3). The results for this question indicate no change in interest level toward a career in architecture. When analyzing the individual responses, two of the five females indicated no change, two indicated a slight increase and one indicated a negative change. This result is the only area where there was a negative response from the pre- to post- survey data.

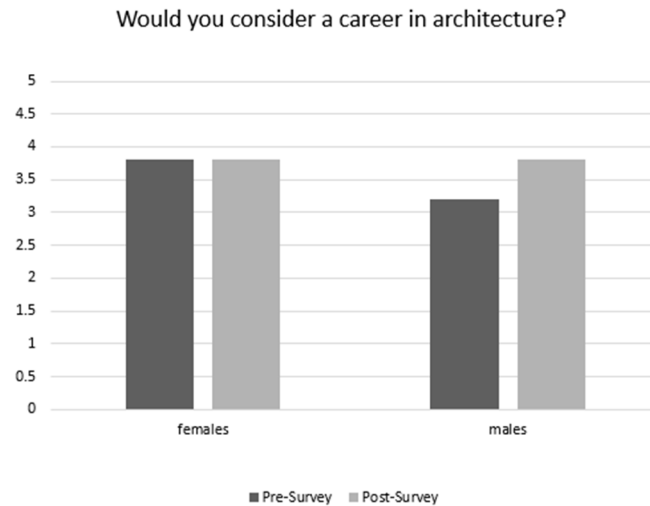


Fig. 3 Participant responses (mean) to Question 3: Would you consider a career in architecture?

Question 4, would you consider a career in engineering, resulted in a mean of 2.25 for females and 3.25 for males on the pre-survey. The post-survey results were a mean of 4.5 for the females and 3.75 for the males (see figure 4). This question represented the most significant change for the females with a doubling on the interest in an engineering career.

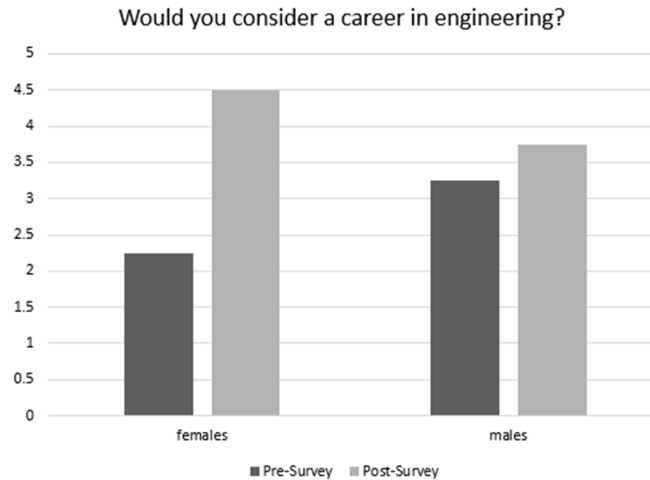


Fig. 4 Participant responses (mean) to Question 4: Would you consider a career in engineering?

Question 5, would you consider a career in construction management, resulted in a mean of 2.50 for females and 2.50 for males on the pre-survey. The post-survey results were a mean of 3.33 for the females and 2.75 for the males (see figure 5). The results of this question provide a unique set of data. The females' and males' mean responses on the pre-survey were both 2.50, while the post-survey results indicated a higher increase, 3.33, than the males, 2.75.

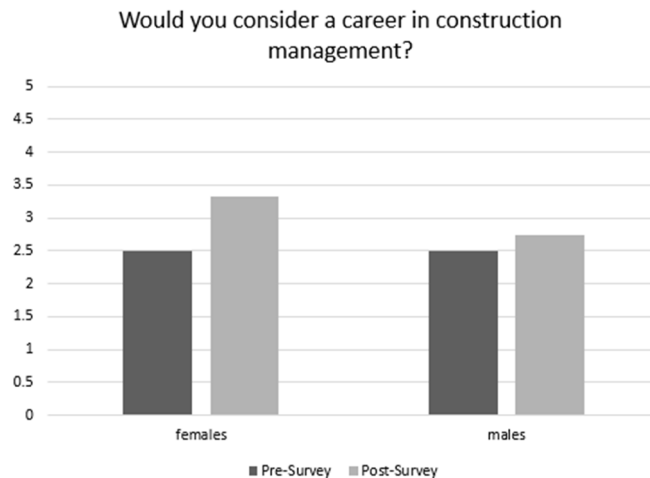


Fig. 5 Participant responses (mean) to Question 4: Would you consider a career in construction management?

Overall, nine of the ten participants showed either neutral or higher responses on all of their post-survey when compared to the pre-survey. For the student who indicated a negative response it was isolated to Question 3, would you consider a career in architecture.

4. Discussion

To address the research questions presented, the survey responses discussed above were analyzed. For the question of how did the camp influence middle grade females' knowledge of the building industry, the authors considered both questions 1 and 2. Both of these questions showed a slight increase in interest for the females over the course of the camp. For the question of how did the camp influence middle grade females interested in building related careers, the authors considered questions 3, 4 and 5. In regards to architecture as a career, the survey results indicated a neutral change in interest. For engineering and construction management a higher level of interest was reported. A 30% increase in consideration of construction management careers was identified and a 100% increase in consideration of an engineering career was identified.

5. Conclusions

The aim of this research was to determine if the summer camp program increased interest in the building industry. The study has confirmed on a small scale, that there is an increased interest in knowledge about the building industry. Additionally, it confirmed an increased interest in engineering and construction management careers. The data related to career interest could be correlated to the instructors and guest speakers associated with the camp, who represent both construction management and architectural engineering for the participants or conversely to the activities within the camp session. Although this study was limited to a small sample size of participants, the data collected confirms that exposure to the building industry does have an immediate impact on students', particularly female students', interest in the field and potential careers. This study was not able to identify if that interest level remains in the days, weeks or months after the completion of the camp. Further research, including expanding this summer camp and other similar camps, could provide a larger sample size for comparison.

References

- BLS (2017). Annual averages, employed persons by detailed industry, sex, race, and hispanic or latino ethnicity. Bureau of Labor Statistics. <https://www.bls.gov/cps/cpsat18.pdf>
- Cooper, R., Heaverlo, C. (2013). Problem solving and creativity and design: What influence do they have on girls' interest in STEM subject areas? *American Journal of Engineering Education – Spring 2013 Special Edition*, 4(1), 27-38.
- Escamilla, E., Ostadalimakhmalbaf, M. (2017). Construction management academy career exploration program: Strategy for recruitment of under-represented minority groups. *53rd ASC International Conference Proceedings*, 261-269.
- Gallagher, C. (April 2022). The construction industry: Characteristics of the employed, 2003-20. *Spotlight on Statistics*. <https://www.bls.gov/spotlight/2022/the-construction-industry-labor-force-2003-to-2020/home.htm>
- Haight, A. (2012) Hungry for Hands-on: Talented, Inner-City Engineering Students, Applied Learning and Employer Engagement in a Vocational-Learning Trajectory. *Journal of education and work*, 25(4), 381–402.
- Lawson, K., Lee, B., Crouter, A., McHale, S. (2018). Correlates of gendered vocational development from middle childhood to young adulthood. *Journal of Vocational Behavior*, 107, 209-221.
- Loughmiller, K., J. Keen and K. Benton. (2018). Improve recruitment and retention based on student interests. *ASEE: First Year Engineering Experience Conference Proceedings*.
- Mohany, M., Utter, K., Fontana, A., Valdes-Vasquez, R. (2019). The development of a construction management summer program for young females – A case study. *55th ASC Annual International Conference Proceedings*, 205-212.
- Nodding, Nel & Witherell, Carol. *Stories lives tell: Narrative and Dialogue in Education*. Teachers College, Columbia University, New York. 1991.
- U.S. Census Bureau, (2022, July). *QuickFacts: Manhattan city, Kansas*. <https://www.census.gov/quickfacts/manhattancitykansas>.