

Study of Imbedding Crochet into Girls' STEM Learning

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Recent STEM programs have made accomplishments in recruiting K-12 girl students to participate in STEM activities. Educational researchers have called for studies of how STEM programs engage girls. However, little research has embedded STEM education with girl education such as their emotional needs, identity and self-expression. This study examines how crochet that was embedded in a STEM summer camp impacts their sense of belonging, creativity, well-being, and STEM learning. For this qualitative study, surveys were conducted with 37 student participants and Discord was used as part of the data sources. Findings indicated that crocheting enhanced students' sense of belonging, creativity, well-being, as well as STEM learning. This study contributes to research in girl education and STEM education practice.

Keywords: crochet; girl education; STEM learning; sense of belonging; constructivist learning environment

Introduction

The quality of STEM education is unsatisfying due in part to the shortage of qualified teachers in urban schools. Noticeably, the percentage of secondary school girl student participation in STEM activities is low. The National Science Foundation sponsors research grants that enhance girl students' motivations for STEM through meaningful learning experiences. Our project, Engaging Girls in Ubiquitous Intelligence and Computing, aimed at advancing the efforts of the ITEST program to broaden the participation of girl students in ubiquitous intelligence and computing through the constructivist learning environment. As fiber artistic expressions and creativity are more girl/woman oriented, we embedded crochet into the program. Based on the constructivist learning and sense of belonging theories, we designed the crochet workshop and offered the Discord tool for online communication. The research question is: What are the effects of crochet on secondary girls' sense of belonging, creativity, and well-being as well as STEM learning?

Theoretical Perspectives

Sense of belonging (SoBL) has been found to impact students' emotional, social, and academic learning (Glass, et al., 2015; Walker, 2019). A strong SoBL can give a student the confidence to ask for help, seek resources, and feel that they are working towards success (Strayhorn, 2019). Positive personal relationships and high-quality communication are indicators of strong SoBL in students (Baumeister & Leary, 1995). A strong SoBL can be an indicator of school enjoyment and perceived school usefulness and is important for maintaining engagement in school for older students (O'Neel & Fuligni, 2013). Dichotomously, where boys' SoBL remains steady throughout secondary schooling, girl students' SoBL has been found to decrease as they age (O'Neel & Fuligni, 2013). Studies have related this inequity to learning environments

which do not meet students' unique needs (Eccles & Roeser, 2009). Our research is to explore how crochet can enhance girls' sense of belonging that may influence their identity.

In Alt's (2015) conceptualization of the constructivist learning environment, constructive activities refer to students 'learn how to learn,' solving meaningful and challenging problems related to real life; a situated contextual activity allows the learner to bring their own strengths to the table to strengthen a student's sense of control over their learning; and social activities emphasize the importance of communication and relationships in learning. Discord is a computer software program that allows for managed communication between groups. Voice and text rooms exist in Discord set only for the girls and mentors as a safe space, allowing students to conference in the way best suited to their needs. Built on the constructivist learning theory, Discord channels were built as the digital learning community that encourages students to share and learn from the interactions. One part of the text channels allowed all the girls to communicate and discuss all the projects and activities: General, Robotics, Arduino, Poems and Essays, and Crochet. In the Team Channel, 10 teams were created for each student and mentor to complete STEM projects. This helps students and mentors create persistent, positive relationships which are key to a strong SoBL (Baumeister & Leary, 1995).

Literature Review

The crochet craft has been around for centuries and boasts many benefits (Taimina, 2018). Of great interest to the invested researchers of the GUIC camp is the impact that practicing crochet has on secondary school girls' emotional and artistic expression, and creativity; particularly those who are immersed in a STEM camp. This interest has given rise to the outlet of introducing crochet to the girls at the summer camp. Literature showed crochet not only increases well-being but also enhances creativity.

Burns and Van Der Meer (2021) found most of the 274 women of 41-60 years old reported that crocheting made them feel calm and happier. Pickrem (2019) experimented with opening a local studio in Canada for women to gather and create a connection to each other through participating in crochet circles. The women were creating conversations through crochet and found a happy place at the studio. Bonding with others in a safe place while exploring creativity through the crochet craft was also witnessed during an experiment by an advocate for women against domestic violence (Sehdev, 2020).

The literature also showed crochet can foster creativity in girls. Studies reported crochet as a great outlet for creativity (Myers, 1985), and the old world craft of crochet can be used as a tool for young women to expand their creativity (Pickrem, 2019; Stalp et al., 2018). Additionally, Kijima et. al (2021) presents research on design thinking and integrating artistic approaches in relation to the importance of STEAM learning and how it complements STEM. Design thinking is purported to spur innovation and harness a sense of creativity. Kijima (2021) explains that STEAM learning can foster greater interest in STEM among adolescent girls. Based on the review, we assume that crochet may increase well-being in these girls, encourage them to explore creativity, and feel confident to express themselves while exploring another connection to STEM learning.

STEM and Crochet

The studied program involved a five-week summer camp in Grades 6-11 to learn Robotics and Arduino programming and integration of these tools to conduct projects in

ubiquitous intelligent systems in tiered teams co-mentored by college students and secondary teachers. Additionally, the camp involved guest speakers, team-building activities, etc. Poem writing and Crochet workshops were offered as a creative outlet to the STEM projects, and as a complement to the STEM component of the overall camp. A crochet workshop was designed specifically to provide a constructive learning environment where the girls learn the history of crochet, witness the demonstration of how math is present in crochet stitches, and more importantly, have an opportunity to display creativity through practicing the crochet art form beyond the workshop.

Crochet refers to the process of creating fabric by interlocking loops of yarn, requiring a hook and yarn (Burns et al., 2021; Myers, 1985). The use of crochet crafts in learning number patterns can help students understand the pattern of numbers (Putri, 2020). In fact, Taimina became known for basic coral forms using hyperbolic crochet to explore mathematics through the crochet craft (Lindsey, 2012; Taiminia, 2018).

The girls were taught four basic stitches during the crochet workshop. The intent was for the girls to start with simpler stitches and progress to more challenging stitches as they understood the concept and became more skilled at each technique. The hands-on learning experience allowed students to explore 1) the slip stitch, 2) the chain stitch, 3) the magic ring, and 4) a pom. Instructions, videos, and demonstrations were conducted for each design as the instructor moved through the room to assist with some of the challenging moments. They grasped the crochet techniques fairly quickly and were encouraged to support their peers through challenges. This allowed for increased communication and enhanced constructive learning. A Discord channel for crochet was created so that girls shared their work in progress and their perspectives and emotions for others' work. At the conclusion of the workshop, the girls were challenged to practice the learned crochet patterns during their free time throughout the camp. They were also encouraged to be innovative, creative, and allow the crochet process to help them with expression and communication.

Methods

Modes of Inquiry

Qualitative methods are useful for understanding participants' perspectives of their experiences (Creswell & Poth, 2018). Case study allows for significant data to be analyzed for evidence of personal, sociocultural, and professional experiences (Yin, 2003) that influences students' identity and well-being. In this study, a qualitative case study was used to explore how crochet impacts students' sense of belonging, well-being, creativity, and STEM learning.

Participants, Data Sources and Data Collection

Participants of the camp included 37 secondary school girl students. Because the study involved human subjects, prior approval was granted from the IRB. Two surveys were conducted after the workshop. Additionally, during the training camp, Discord channel was opened for crochet and the Discord posts were used as a data source to examine the impacts.

Two data sources were analyzed: a qualitative survey and Discord conversations. The survey was conducted one week after the crochet workshop. All the participants signed on the informed consent form for the research. Students discussed their crochet work through Discord.

Data Analysis

Content analysis was used for the survey because we were interested in finding trends about how students felt about their learning and experiences. First, responses were reviewed using open coding to organize the themes. Next, selective coding was used to identify trends. Finally, these codes were analyzed for themes. Discord functions as an application and a web interface. For Discord, Stanfill (2015) explained textual analysis as one approach of discourse analysis. The selective coding was used to identify trends that support the themes uncovered through the content analysis of the survey. Two researchers independently reviewed the data to find strong examples for each theme and to support intercoder reliability.

Findings

The findings are outlined in four themes as shown in Table 1. Additional examples for each theme were included in the full paper.

Sense of belonging and communication. Research indicates that crochet can bring a sense of community and agency for people (Mayne, 2016). In the survey, five girls expressed how practicing crochet helped them interact with their peers more freely and allowed for easy self-expression. S23 shared that crochet allowed her to “express myself and it was very fun and enjoyable”. These findings confirmed with the previous research that crochet improves interaction, social confidence, and feelings of belonging (Mayne, 2016; Pickrem, 2019; Sehdev, 2020).

Creativity. Crochet is a great outlet for creativity (Myers, 1985). As noted in Table 1, ten girls expressed how they were able to tap into their creativity. One girl touted that she was able to use her creative mind to create items with yarn. A few of the girls communicated in Discord that they were making scarves and shared pictures of their work. They explored the stitches and pushed through the challenges to discover their own creative crochet designs. Student R showed her work and admitted that she made a mistake but kept working on her design. She also mentioned that it looks like the state.

Well-being. The impact of crochet on well-being was brought to light. Eight girls shared how crochet was a stress reliever, and enhanced calming and peaceful effects for them (Burns & Van Der Meer, 2021). Six girls indicated in the survey that practicing crochet helped them “feel calm”, “relaxed” and “relieved stress”. In the Discord communication, girls talked about how the crochet process was “very satisfying”, even when they made a mistake and had to start over with their project.

STEM learning. Ample feedback regarding the impact of crochet on multiple areas of the girls’ lives were observed as noted in Table 1. The merging of fibers with high tech or math encouraged STEAM learning (Stalp et al., 2018) and more interest in ‘math in real life’. Three girls expressed that crochet connected to math and STEAM by including fabric in STEM creativity conversations and raising the visibility of making the connections of handicrafts to the hard sciences (Stalp et al., 2018). Most girls became lively and engaged in the crochet process as they learned how to count stitches, increase and decrease stitches, and multiply stitches to create a design made of yarn. S17 expressed that crochet “opens our minds to new ways of STEAM”.

Scholarly Significance

This study is significant in several ways. First, our study contributes to the STEM learning program design for girls in secondary schools with two closely related theories: constructivist learning environment theory and sense of belonging theory. Embedding artistic activities into the STEM learning activities may interest girl students more. Second, Discord was used for students to communicate. This tool served as a platform for communication and sharing; in this study it also offered significant examples for students' interactions and learning. Third, the study found the effects of crochet on secondary girls' sense of belonging, creativity, well-being, as well as STEM learning; these findings added new knowledge to the research of crochet in girl education and STEM program design.

References

- Alt, D. (2015). Assessing the contribution of a constructivist learning environment to academic self-efficacy in higher education. *Learning Environments Research*, 18(1), pp.47-67.
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117(3), 497-529.
- Burns, P., & Van Der Meer, R. (2021). Happy Hookers: findings from an international study exploring the effects of crochet on wellbeing. *Perspectives in Public Health*, 141(3), 149-157. <https://doi.org/10.1177/1757913920911961>.
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among the five approaches*. Sage.
- Glass, C.R., Kociolek, E., Wongtrirat, R., Lynch, R.J., & Cong, S. (2015). Uneven experiences: The impact of student-faculty interactions on international students' sense of belonging. *Journal of International Students*, 5(4), 353-367.
- Kijima, R., Yang-Yoshihara, M., & Maekawa, M. S. (2021). Using design thinking to cultivate the next generation of female STEAM thinkers. *International Journal of STEM Education*, 8(1), 1-15. <https://doi.org/10.1186/s40594-021-00271-6>.
- Mayne, A. (2016). Feeling lonely, feeling connected: Amateur knit and crochet makers online. *Craft Research*, 7(1), 11-29. https://doi.org/10.1386/crre.7.1.11_1.
- Myers, C. (2011). Hooked on crochet. *Countryside and Small Stock Journal* (1985), 95(4), 77-.
- O'Neel, C. G., & Fuligni, A. (2013). A longitudinal study of school belonging and academic motivation across high school. *Child Development*, 84(2), 678-692. <https://doi.org/10.1111/j.1467-8624.2012.01862.x>
- Pickrem, P. (2019). "It's the fibre that brings us together" CROCHET BASICS; Crochet Crowd creating sense of family as they come together to craft. Chronicle-Herald (Halifax, N.S.).

Putri, R. I. I. (2020, February). Crochet crafts as a context using LSLC in number pattern. In *Journal of Physics: Conference Series* (Vol. 1470, No. 1, p. 012082). IOP Publishing.

Sehdev, M. S. (2020). The time of crochet: Interruption, plasticity, and the domestic in Delhi. *Feminist Anthropology*, 1(2), 136-148 .<https://doi.org/10.1002/fea2.12026>.

Stalp, M. C., Gardner, E. A., & Beaird, A. (2018). ‘I like knowing when the zombies arrive, I won’t be naked’: Young women and leisure handcrafting in the United States. *Craft Research*, 9(1), 41-58.

Stanfill, M. (2015). The interface as discourse: The production of norms through web design. *New Media & Society*, 17(7), 1059-1074. <https://doi.org/10.1177/1461444814520873>

Strayhorn, T. L. (2019). *College students’ sense of belonging: a key to educational success for all students* (2nd ed.). Routledge.

Taimina, D. (2018). Tidbits from the History of Crochet. In *Crocheting Adventures with Hyperbolic Planes* (pp. 76-83). CRC Press.

Walker, S. M. (2019). *A constructivist grounded theory of the influences and practices that are thought to promote a sense of belonging in a primary school context*. ProQuest Dissertations Publishing.

Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). SAGE Publications, Inc.

Table 1 Findings of Effects of Crocheting

Themes	Explanation	Discord Examples	Survey Examples
STEM Learning	Using addition, subtraction, multiplication and geometric shapes as they learned and practiced new stitches, the process of crochet helped them see math in real life, and in artistic form.	R: “There are several types of art that I was surprised had a connection to STEM”	S17 W2: “open our minds to new ways of STEAM” S19 W2: “to use math” S27 W2: “how to see math in crocheting”

Creativity	Crochet provides opportunities for girls to have fun, and make their own creations during and after the camp.	E: "I'm making a scarf" El.: "same" E: "I'm one row in" L: "I just finished this flower" R: "omg. It's so pretty" R: "Yall, I made a mistake and now it looks like [the state]" E: "my scarf" R: "it would be cool if you had a bunch of tiny balls and crochet them into your scarf" M.: "Made a scarf" E: I'm making a scarf too @E, that's my thing" M.: "Darn, I was making a scarf" S.: "I'm making progress" E "i have the original scarf" M.: "Cool Cool. You gonna make anything else?" E: "probably more bracelets. I need them to be all the way up my arm" M.: "Nah, Both arms?" E: "Yes" D: "Look what I made yesterday though" El.: "Nice" M.: "Uh. Nice scarf" R: "omggggg. so pretty" D: "My scarf is not done but it looks pretty good in my opinion" A: "that's super cool!! great job" D: "Thank you" R: "Yooo, It looks great"	S1 W1: "practice my crochet skills and make many different designs that I like" S5 W2: "use our creative minds to create items with yarn" S6 W2: " fun and easy to do once I got the hang of it" S8 W2: "artistic and fun to do" S15 W2: "crochet helps us use our creative minds to create items with yarn" S16 W2; "Crochet can do so many things, and I want to learn more" S19 W2: "be creative" S22 W2: "crochet had brought us a new talent" S28 W2: "it sparked a lot of creativity" S30 W2: "be creative"
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Well-being	Positive effects of crochet on mental health benefits including the calming, repetitive movements of crochet in dealing with depression, anxiety and stress.	E: "I undid my scarf. Im restarting. I skipped the last stitches" S.: "OH NO" E: "it was really satisfying though" S.: "Well, at least that's something" E: "I messed it up, and it was really satisfying" D: it isssssssssss.	S5 W2: "it took a break with the technology and stress and continued something else while still learning" S7 W2: "bring me peace and something to do as future hobbies" S13 W2: "it is fun and calm" S15 W2: "the crochet is a fun hobby that is calming and fun to do" S16 W2: "very relaxing" S19 W2: "to release stress" S21 W2: "helps me focus way more" S27 W2: "It taught me to be patient"
Communication/Sharing	Communication with their peers as they jointly studied crochet stitches, helping each other figure out stitches, and expressed themselves in unique ways about their creative crochet ideas.	R: "i'm almost gonna just go around reading everyone's name tags. i know like 10% of y'all" S.: "I should have lied and made your quest harder." R: "nah your friend E snitched lol" E: "I think this channel became more of a "get to know each other" channel than "crochet" R: "my goal is to know all your faces and names by July 1st."	S9 W2: "crochet has kept me from checking out completely so I can stay involved with the class" S20 W2: "interact with others" S23 W2: " express myself and it was very fun and enjoyable" S32 W2:" express myself" S38 W2: "crochet was fun"