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Prison Bars & Bird Cages: Conducting an Arts-Based Participatory Research Project with Undergraduate Women in STEM

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Abstract

The "chilly" science, technology, engineering, and mathematics (STEM) climate in undergraduate settings has been widely documented, as women in STEM majors frequently face discrimination, microaggressions, and implicit bias from their professors and peers. While undergraduate research experiences can help women in STEM overcome some of the barriers they face, these opportunities are not always accessible and inclusive. Although there is a breadth of literature on this topic, many studies utilize traditional quantitative and qualitative methods and do not take the authentic, individualized voices of these women into account. The present study integrates two arts-based participatory methodologies—Photovoice and collage inquiry—to explore the following questions: (1) What are the experiences of women in STEM majors at a large midwestern research-intensive university? (2) How do these women experience conducting and/or seeking research opportunities? Four themes emerged from the analysis of the triangulated data: (1) lack of equity in STEM, (2) lack of awareness of opportunities, (3) confidence in STEM abilities, and (4) passion for STEM. While the first two themes encompass barriers that women in STEM face, the second two themes demonstrate the strengths of women in STEM.

Keywords: women in STEM, Photovoice, photography, collage inquiry, collage, participatory methods, arts-based methods, arts-based participatory methods

Introduction

Women have been historically underrepresented in science, technology, engineering, and mathematics (STEM) fields, particularly in higher education (Hill et al., 2010; Iwasaki, 2015). The

"chilly" STEM climate in undergraduate settings has been widely documented, as women in STEM majors frequently face discrimination, microaggressions, and implicit bias from their professors and peers (Thoman et al., 2014; Cole & Espinoza, 2011). While undergraduate research experiences can help women in STEM overcome some of the barriers they face, these opportunities are not always accessible and inclusive (Rosenthal et al., 2011). we

Existing literature on women in STEM highlights various challenges and factors contributing to their underrepresentation. For example, Hill et al. (2010) emphasizes the role of social and environmental factors, including stereotypes and lack of support, in deterring women from pursuing STEM careers. Similarly, Iwasaki (2015) discusses the importance of supportive environments and mentorship in encouraging women to persist in STEM fields.

Despite the wealth of literature on this topic, many studies have relied on traditional quantitative and qualitative methods, which may not fully capture the nuanced experiences of women in STEM (Adedokun et al., 2013; Espinosa, 2011; Jones et al., 2010; Kardash, 2000; Rosenthal et al., 2011; Wilson & Kittleson, 2013). This study addresses this gap by utilizing two arts-based participatory methods, Photovoice and collage inquiry, to explore the experiences of undergraduate women in STEM. These methods allow participants to express themselves visually, offering a more holistic understanding of their experiences.

By employing these innovative methods, this study aims to provide a deeper insight into the challenges and experiences of women in STEM, ultimately contributing to the existing literature in the field. Furthermore, comparing the findings of this study with existing literature may help identify new insights or perspectives it offers, highlighting its significance in advancing our understanding of women's experiences in STEM fields.

Undergraduate Women in STEM: Seeking Research Opportunities

The Characteristics of Excellence in Undergraduate Research (COEUR) report emphasizes that undergraduate research ideally involves institutional and administrative support, the commitment of scholarly faculty, accessible opportunities in multiple fields, and funding (Rowlett et al., 2012). For this study, undergraduate research is defined as undergraduate students in any field of study conducting research with a faculty mentor, encompassing any field or type of research, scholarly activities, or creative practice within various settings (Guy & Feldman, 2023). While both formal, university-established undergraduate research programs and informal mentored research experiences exist, these can all be categorized as undergraduate research experiences (UREs).

Studies investigating the impact or effectiveness of various UREs each highlight at least one benefit for undergraduate students of various demographics. Implementing programs and programmatic factors have been shown to positively impact women in STEM in various ways (Dewey et al., 2022; Duboue et al., 2022; Ghebreyessus et al., 2021; Inkelas, 2011; Jones et al., 2019; Krim et al., 2019; Ong et al., 2011; Ramsey et al., 2013; Rosenthal et al., 2011; Samad et al., 2021; Starr et al., 2020; Werth et al., 2022). For instance, women in STEM often experience a

low sense of belonging (Thoman et al., 2014), and UREs have been shown to positively impact this sense of belonging (Rosenthal et al., 2011).

Participating in UREs has been associated with several positive academic outcomes, both in the classroom and in terms of persistence. Studies have reported increases in grade point average (GPA) following URE participation (Fechheimer et al., 2011; Maton et al., 2000). Additionally, retention and graduation rates improve for students engaging in UREs (Barlow & Villajero, 2004; Eagan et al., 2013; Jones et al., 2010). URE participants are also more likely to enhance their cognition and problem-solving skills. Hunter et al. (2006) found evidence for "cognitive growth," and Zhan (2014) noted that students were better prepared to solve real-world problems due to UREs.

Importantly, several studies indicate considerable improvement in research skills (Adedokun et al., 2013; Campbell & Skoog, 2004; Kardash, 2000; Tigno et al., 2009; Odera et al., 2015). UREs also increase students' inspiration to pursue research-related and science-centered careers (Adedokun et al., 2013; Odera et al., 2015; Russell et al., 2007). Interest in, preparation for, and likelihood of attending graduate school also increase (Barlow & Villajero, 2004; Barnes, 2015; Carter et al., 2009; Maton et al., 2000; Russell et al., 2007). UREs have been found to impact self-efficacy, a variable that stimulates the persistence of women in STEM (Adedokun et al., 2013; Cole & Espinoza, 2011; Heilbronner, 2012). Campbell and Skoog (2004) report that a specific URE experience increased students' confidence and motivation. UREs also enhance student engagement and sense of belonging (Fechheimer et al., 2011; Rosenthal et al., 2011).

The outcomes of UREs can address the barriers and strengths of women in STEM, thus encouraging the persistence of these groups. For instance, UREs require faculty mentors (Rowlett et al., 2012), and those with a strong mentorship component are particularly effective (Campbell & Skoog, 2004). Women in STEM especially benefit from supportive mentors (Kim et al., 2011). Moreover, UREs can reduce implicit stereotype endorsement (Ramsey et al., 2012).

The literature does not fully consider the impact of UREs on women in STEM; therefore, these women are excluded from conversations related to program development in higher education. It is crucial to include multiple perspectives from various groups in these discussions for both equity-based and economic reasons (Espinosa, 2011; Ong et al., 2011). Thus, including a variety of perspectives is essential when discussing both the persistence of women in STEM and the development of inclusive and accessible UREs, which can be achieved through participatory methods, which empower participants and enhance research quality (Anderson et al., 2007; Goodhart et al., 2006; Guy & Arthur, 2021; Jacquez et al., 2013; Williams & Lykes, 2003).

Participatory Methods in STEM Research

The use of participatory methods in STEM research has emerged as a valuable approach to understanding and addressing the unique experiences of women in these fields. Arthur and Guy (2020) conducted a study that employed participatory methods to explore the experiences of

women engineering students during co-op placements. Their findings underscored the importance of these methods in capturing the nuanced challenges and successes of women in STEM. Building on this work, Guy and Arthur (2021) investigated the impact of a group-level assessment on undergraduate women engineering students. Their study demonstrated how participatory assessments can empower women in STEM, providing a supportive environment for their academic and professional development.

In a different context, Guy and Feldman (2021) organized a future-creating workshop for undergraduate women in STEM, allowing participants to envision their future careers in STEM fields. This workshop provided a space for women to explore their aspirations and goals, highlighting the potential of participatory methods to inspire and empower women in STEM. Guy and Feldman (2023) continued their work through a participatory action research project that focused on the intersection of family life and STEM education for undergraduate women. This project engaged participants in co-creating knowledge and solutions, emphasizing the importance of including diverse perspectives in STEM research.

In a related study, Guy et al. (2020) discussed the complexities of defining and navigating *action* in participatory action research within STEM education. Their work highlighted the need for careful consideration of the role of action in research processes involving diverse stakeholders. Furthermore, Guy and Rogers (2022) demonstrated the versatility of participatory methods by using Photovoice in an online psychology of gender course. This approach facilitated difficult discussions and increased student engagement, illustrating the potential of participatory methods in enhancing learning experiences in STEM-related courses.

Overall, these studies showcase the diverse applications and benefits of participatory methods in STEM research, emphasizing their role in empowering women and promoting inclusivity in these fields. The current study will add valuable insights to the existing literature by utilizing arts-based participatory methods, specifically Photovoice and collage inquiry, to explore the experiences of undergraduate women in STEM. These methods offer a unique and innovative approach to research, allowing participants to express themselves visually and creatively.

By incorporating arts-based methods, the study aims to capture the nuanced and often complex experiences of women in STEM in a way that traditional research methods may not fully capture. These methods provide a platform for participants to share their stories and perspectives in a more personal and meaningful way, potentially revealing insights and perspectives that may have been overlooked or marginalized in previous research.

Furthermore, arts-based methods have the potential to create a more inclusive and empowering research environment, where participants are actively engaged in the research process as co-creators of knowledge. This approach aligns with the study's goal of centering the voices and experiences of women in STEM, highlighting their agency and resilience in the face of challenges.

Photovoice

Photovoice is a participatory evaluation method that is informed by feminist thought (Jurkowski, 2008) in which participants "document their own realities and systematically analyze them" (Herr & Anderson, 2015, p. 33) to instigate positive social change (McIntyre, 2008). It involves the process of taking photographs in response to a prompt or several prompts, sharing those photos with a team of coresearchers, and discussing and analyzing the data as a group (Griebling et al., 2013). Photovoice has been used to successfully serve several purposes, such as skill- and knowledge-building (Gordon & Edwards, 2012; Robinson-Keilig et al., 2014), addressing and prioritizing community concerns (Hergenrather et al., 2009), informing public health policy (Wang, 1999), and contributing to needs assessment (Wang & Burris, 1997). The Photovoice process is inclusive, as almost everyone can take a photograph, whether it be children or adults. Photovoice can help visualize knowledge differently, providing an alternative perspective for visualizing and analyzing data (Gonzales & Rincones, 2013), and its participatory nature can lead to feelings of empowerment for participants (Goodhart et al., 2006).

In the context of women in STEM, there is evidence that Photovoice can work well with this population. Multiple studies have shown Photovoice projects to empower women both individually and within their communities (Clover, 2011; McIntyre, 2003; Wang, 1999). Moreover, Photovoice has been shown to be effective in higher education (Gonzales & Rincones, 2013), particularly with student engagement and critical thinking, and student-instigated change in this setting (Garner, 2014; Goodhart et al., 2006; Gordon & Edwards, 2012; Massengale et al., 2016; Robinson-Keilig et al., 2014).

Collage Inquiry

The method of collage has been used in qualitative analysis, social justice–informed inquiry, and the inclusion of marginalized voices in research (Butler-Kisber & Poldma, 2011; Gerstenblatt, 2013; Yuen, 2016). Collage inquiry values both process and product and can be used as a form of reflection and an arts-based research method to glean information about a research question (Butler-Kisber & Poldma, 2011). Collage-making has been shown to be successful with women participants within a participatory project, namely by improving understanding of social justice issues, making connections within communities, and engagement in research (Yuen, 2016; Butler-Kisber & Poldma, 2011).

Collage can also be used as a form of a qualitative analysis that represents lived experiences of historically oppressed groups and is beneficial within the process of data interpretation in participatory research (Butler-Kisber & Poldma, 2011; Gerstenblatt, 2013). Within the process of collage inquiry, participants create individual collages on a canvas or sheet of construction paper in response to a prompt or question (Yuen, 2016). Collages can include a combination of found images, words, and/or phrases. Collage creation is followed by discussion about and reflection upon the collages, and what they each mean in the context of the research question(s) (Butler-Kisber & Poldma, 2011; Yuen, 2016).

Research Questions

The present study integrates two arts-based participatory methodologies—Photovoice and collage inquiry—to explore the following questions:

1. What are the experiences of women in STEM majors at a large midwestern research-intensive university?
2. How do these women experience conducting and/or seeking research opportunities?

Methods

Participants

Participants of this study included six undergraduate women at a large public research university in the Midwest. Participants were recruited via email lists, primarily ones that communicated with students in STEM majors and classes. The women were all pursuing degrees in STEM, but each had different majors within STEM and varied in terms of their year of study (see Table 1). When asked to self-identify race/ethnicity, four participants identified as White, one as Black, and another as Appalachian. The participants participated in this study as coresearchers, in alignment with participatory research tenets.

Table 1
Coresearcher Demographics

Coresearcher #	Year in School	Major	Race/Ethnicity
1	1	Biological Sciences	White
2	2	Education, Psychology minor	White
3	2	Chemical Engineering	Black
4	3	Biological Sciences	White
5	4	Biomedical Engineering	White
6	4	Psychology	Appalachian

Photovoice Method

The current Photovoice project involved two major meetings: 1) a planning session and 2) an analysis session, with several weeks in between for the women to take photographs. The planning session included Photovoice training and the development of the prompts. For the training portion, we provided the coresearchers with the background of Photovoice as a method and an outline of the overall process. We discussed ethics surrounding Photovoice, including the nuances of consent in photography. The coresearchers were provided a consent form (see Appendix A) in case any of the photographs were to include identifiable faces (see Appendix A for training and consent documents). Next, coresearchers brainstormed ideas for prompts they wanted to explore, discussed how many prompts to include, and finalized the following two prompts:

1. Take a photograph that reflects your personal experience as a woman in STEM.
2. Take a photograph that represents your relationship to research as a woman in STEM.

After a few weeks of taking photographs, the coresearcher group reconvened to discuss. Starting with the first prompt, each member presented their photograph, explaining their photo and the process of taking it. Following each photo presentation, the coresearchers discussed and reflected upon the photo as a group and took turns taking notes during this meeting. Following the discussion of the first prompt, the coresearchers identified salient themes that they found were present across all photographs. This process was then repeated for the second photo prompt. Finally, the coresearchers discussed what actions could be taken to improve their experiences as women in STEM with intersectional identities; notes were taken during this discussion.

Collage Method

The coresearchers chose to create collages that reflected their experiences as women in STEM with intersectional identities. The coresearchers chose from a variety of magazines, construction paper, and markers, and they individually created collages using images, words, and/or phrases using the provided materials. Following the collage-making, each coresearcher presented their collage and explained their process (Figures 1, 2, 5, and 6 show the four collages that were created). Much like with the Photovoice data, the coresearchers identified themes that were present across all the collages. Notes were taken during the presentations and discussions of the collages. The collage data inspired further exploration regarding intersectional identities, and we conducted an activity to explore this further due to coresearchers' interest; although this activity was not analyzed with the rest of the data, information regarding the process is available in Appendix B.

Data Analysis

The Photovoice and Collage Inquiry data included the photos and collages themselves, as well as our notes from the discussion and reflection portions of these methods. We triangulated three sources of data—Photovoice data, collage inquiry data, and our personal memos following each process—and analyzed them collectively using the Constant Comparison Method of qualitative data analysis (Maykut & Morehouse, 1994; Memon et al., 2017). We followed the four stages of analysis as described in Memon et al. (2017), and conducted the process as follows to reach the final themes:

1. **Inductive category coding**: After compiling and reviewing all the data in preparation for stage one of the coding process, we created an initial list of codes based on the triangulated data as a whole.
2. **Refinement of categories**: Then, we determined rules for sorting the codes into main themes, and refined our codes based on these inclusion criteria.
3. **Exploration of relationships across categories**: Next, we grouped the codes further into overarching categories.

4. **Integration of data**: We finalized the key themes and synthesized codes to determine relationships between the themes.

IRB

The current study was approved by our university's IRB as exempt.

Results

Four themes emerged from the analysis of the triangulated data: (1) lack of equity in STEM, (2) lack of awareness of opportunities, (3) confidence in STEM abilities, and (4) passion for STEM. While the first two themes encompass barriers that women in STEM face, the second two themes demonstrate the strengths of women in STEM.

Lack of Equity in STEM

The first key theme, lack of equity in STEM, highlights the isolation women feel in their classes and labs due to being one of the only women, including being treated unfairly because of their gender identity. As one coresearcher described, despite the large enrollment, "you still feel isolated [from your peers]." During the Photovoice discussion, a coresearcher wondered: "You feel stuck as a woman in STEM and like women are progressing, [but] are the numbers really changing?" This question led to a discussion about how women in STEM often feel alone and isolated, with another coresearcher revealing her experience in her STEM coursework, sharing, "In my [calculus] class, with only a few girls, even though there are other people, you still feel . . . like the odd one out." This conversation arose during the collage-making process as well.
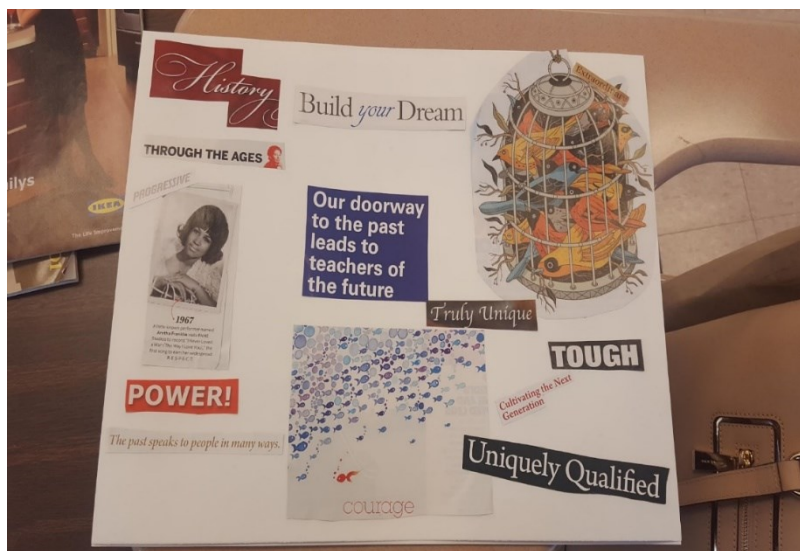
Figure 1. Trapped in a Cage

The woman who created the above collage (Figure 1) explained that women in STEM tend to feel "trapped in a cage on the inside [and] alone on the outside" owing to their marginalization in science fields. As another woman explained:

> I noticed if my professor calls on a guy, they're much more likely to talk loudly, [not] care what they say; [there are] no consequences. But a lot of the girls will feel very intimidated by it. Our male professor comes up to us with a microphone and [asks us to] answer in front of 400 people.

Figure 2. Take Your Pick

The coresearcher who created the above collage (Figure 2) expressed that "[from a] woman's perspective, [you need to] quit what you're doing for family." The "take your pick" image on the left-hand side of Figure 2 is meant to represent that women are forced to choose between pursuing a STEM career and starting a family.

In reference to the below photograph (Figure 3), a coresearcher continued to reflect on this issue:

> I like the prison bars because a lot of the things we experience comes from ourselves, our experiences. Part of it is how we grow up, but part of it is our self-confidence and limiting ourselves.

Figure 3. Prison Bars

The women also expressed that they feel "under-appreciated [and] overlooked," which impacts their self-esteem. One woman explained how "women undervalue ourselves; [we] feel under-qualified."

Lack of Awareness of Opportunities

Another barrier that arose for women in STEM seeking research opportunities was the lack of awareness. The woman who took the below photograph (Figure 4) explained, "she's waiting for someone to answer her questions and pay attention to her needs but they aren't" because "there's no one to guide you" concerning finding and knowing about research and career opportunities. This discussion led to another coresearcher reflecting upon this disparity:

> As an undergraduate, research is a very mysterious object. A lot of students are confused by what it is and how to find it, there are major disparities. The lens that you look through is different—tinted. This applies to all undergraduates but especially women. Why does this problem of hearing about research and not knowing what it is exist?
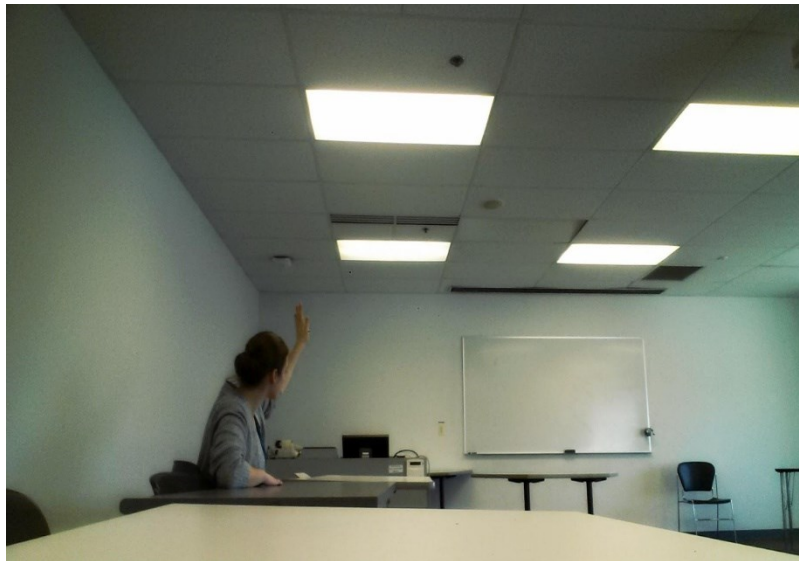
Figure 4. "There's no one to guide you."

During the Photovoice discussion, a coresearcher explained that "STEM really only tells you there are certain limited things you could do with it, especially growing up as a woman" and that women are not always aware of the opportunities they could seek in their future careers. Another woman explained, "It's a requirement that [students] have research experiences and things like that, but there's too many students and too few opportunities."

Confidence in STEM Abilities

As there were barriers that the women felt hindered them in their STEM journeys, they also asserted that they had several strengths as well, which manifested in both perseverance and confidence in STEM abilities.

Figure 5. Don't Stop Believing!

The above collage (Figure 5) was created to be a confidence-builder for women in STEM. The co-researcher who created this collage indicated that her confidence stems from believing in herself, hence the "don't stop believing" text embedded in the image. Participants indicated the importance of confidence as an internal strength, including building confidence in others. A woman responded to the above collage (Figure 5): "you need [confidence] to pull yourself through." Furthermore, another coresearcher's collage focused on the future, including going into a STEM career (Figure 6). She discussed how while there are challenges associated with a STEM career, the benefits and fulfillment far outweigh these challenges.
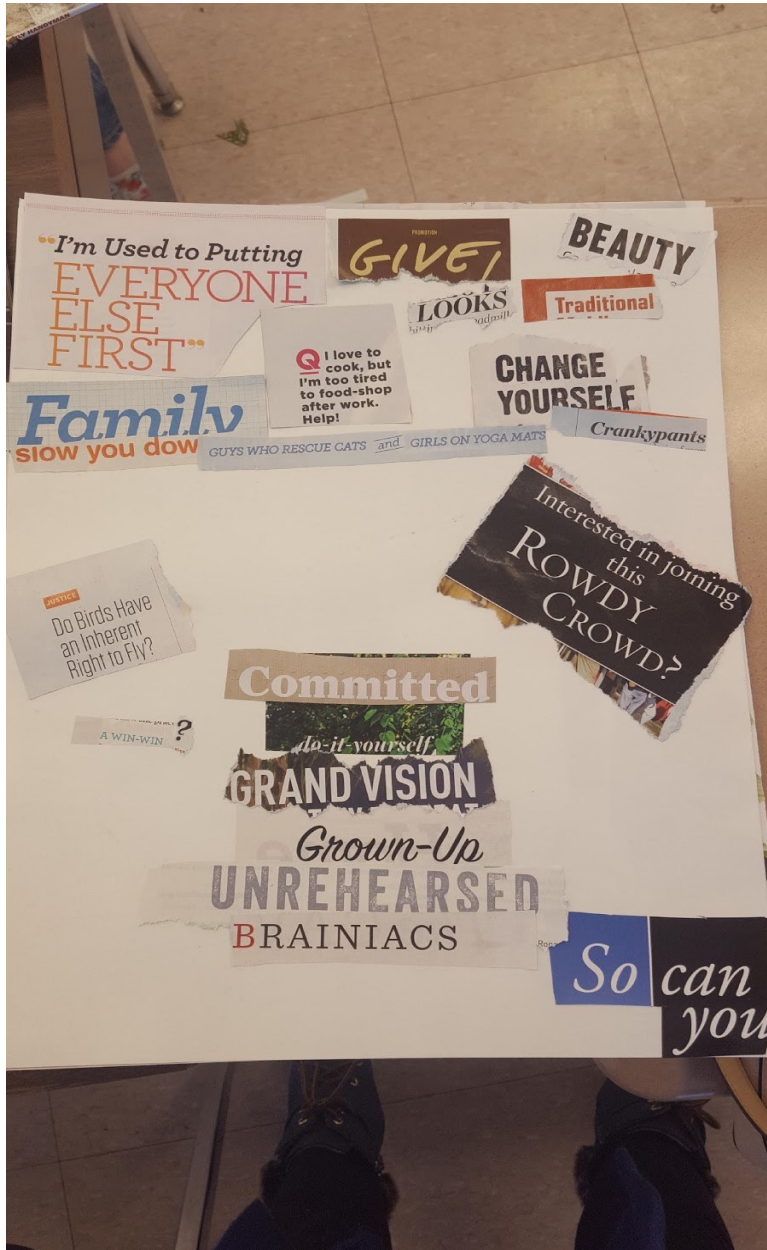

Figure 6. So can you

Passion for STEM

The women emphasized that one of the purposes of research—gaining knowledge—greatly contributed to their own learning and interest in STEM. A researcher described her process in taking the below photograph (Figure 7): "I'm just looking at it and wondering what's in there. That's kinda how I feel about research: what's in there? What can I discover?"


Figure 7. Discovery

In response to the photograph of the pillars (Figure 3), a coresearcher explained that this image represents newfound knowledge and that research is "where the discovery comes in; in that mysterious opening, you can't see much. There's no one to guide you but an opportunity to go forward and grow." Replying to this comment, another woman reflected, "The pillars remind me of prison bars, with the contrast, but then the opening reminds me of growth and growing and going forward."

During the Photovoice discussion, the women pointed out that "mentorship and accessibility are two [items] we've heard about consistently." The coresearchers agreed with this, with one asserting about Figure 8:

> I feel like there's a need for that [photo content]. It would have been good to have a mentor, someone to show me what the right direction was earlier. I was waiting for someone to help me.
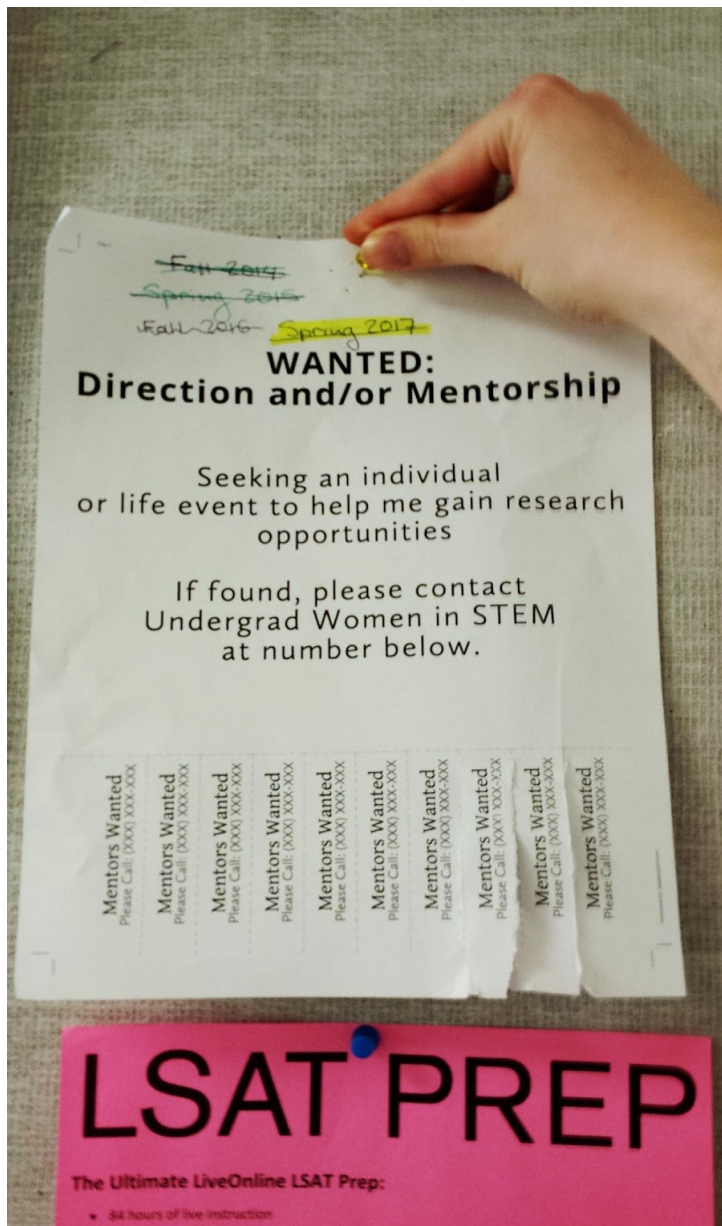
Figure 8. Mentorship Wanted

Another coresearcher agreed, saying, "I definitely think it's a need; I was lucky to have that mentorship and don't know where I'd be without it."

Discussion

Although women are historically underrepresented in STEM fields, including in higher education, UREs may help with the retention of women in STEM majors. However, there are still several barriers to finding and participating in STEM research opportunities that undergraduate women face. The qualitative data analysis revealed that while the women coresearchers felt they were impeded by both (1) lack of equity in STEM and (2) lack of awareness of opportunities, their

(3) confidence in STEM abilities, and (4) passion for STEM assisted them in their success and retention in their respective STEM fields. These themes demonstrate that if research opportunities are created and made accessible in a more equitable way, participating in research can assist women in STEM in filling their need for discovery and passion for their work, as well as improve their confidence, leading to increased retention.

The qualitative data analysis offers insights into the experiences of women in STEM majors at a large midwestern research-intensive university. The identified themes of lack of equity in STEM and lack of awareness of opportunities depict the formidable challenges these women encounter in accessing research opportunities. Despite these hurdles, confidence in STEM abilities and passion for STEM emerge as pivotal drivers of their success and retention in their respective fields, highlighting the potential impact of creating more equitable and accessible research avenues in enhancing women's experiences in STEM. By facilitating the fulfillment of their passion for discovery and enhancing their confidence, such efforts may lead to increased retention rates among women in STEM.

Additionally, while women in STEM may face challenges in finding and participating in research opportunities, their experiences are influenced by their confidence in their abilities and their passion for STEM. This study's emphasis on personal attributes and motivations adds a nuanced layer to existing literature, which often focuses on external factors like gender biases and lack of mentorship. It underscores the need for multifaceted interventions and support systems that address both external barriers and internal motivations.

The existing literature on women in STEM has identified various factors that contribute to the underrepresentation of women in these fields, including gender biases, lack of mentorship and support, and societal stereotypes. The findings of this study, which highlight the importance of confidence and passion in STEM, add to this body of literature by emphasizing the role of personal attributes and motivations in women's retention and success in STEM.

By offering new insights or perspectives on women in STEM, this study has the potential to inform future research and interventions aimed at increasing the representation and retention of women in these fields. By building on the findings of this study, researchers can continue to advance our understanding of the factors that influence women's experiences in STEM and develop strategies to support their success.

Limitations

While the study illuminates important aspects of women's experiences in STEM, it also has some limitations. The sample size of six undergraduate women from a single university is not representative enough to draw generalizable conclusions about the broader population of women in STEM. There are also limitations to using arts-based methods. For instance, analyzing photos and art can be seen as subjective, and some participants may not be comfortable with the notion of using a photograph rather than a literal image to represent an idea. Challenges that may emerge

in a Photovoice project, specifically, include tensions between individual and collective needs, and difficulty striking a balance between process and product, as with many participatory projects (Clover, 2011).

The reliance on arts-based methods, such as Photovoice and collage-making, might introduce subjectivity and interpretation biases into the data analysis process. Analyzing photos and art can be inherently subjective, as interpretations of visual imagery can vary widely among individuals. Some participants may also not be comfortable with the notion of using a photograph to represent an idea rather than a literal image, which could impact the accuracy and reliability of the data collected through these methods.

Furthermore, as with any participatory research method, Photovoice requires careful consideration of the role of the researcher and participant in the research process, data ownership, dissemination, and action (Guillemin & Drew, 2010). One issue that comes up with using collage-making in research, in particular, is the question of who should be creating the collage—researchers, participants, or both—which can be considered part of the ambiguity in defining the relationship between researcher and participant (Butler-Kisber & Poldma, 2011). Concerns may also arise regarding how visual works should be evaluated in research, as with Photovoice (Butler-Kisber & Poldma, 2011).

Significance & Implications

The findings of this study shed light on the factors influencing the retention of women in STEM fields, particularly through UREs. By identifying barriers, such as lack of equity and awareness, and highlighting the importance of confidence and passion in STEM, the study provides valuable insights for improving the representation and retention of women in STEM majors.

Practically, these findings suggest that efforts to increase the accessibility and equity of research opportunities in STEM could have a positive impact on the retention of women. Creating an environment that fosters confidence and supports the passion of women in STEM may lead to increased retention rates and a more diverse and inclusive STEM community.

This study also emphasizes the importance of incorporating participatory methods, such as Photovoice and collage-making, into research on underrepresented groups in STEM. These methods allow participants to express their experiences in their own words and images, providing a more nuanced understanding of their challenges and successes. Overall, the study highlights the potential for using participatory methods to empower underrepresented groups in STEM and inform strategies for increasing their representation and retention in these fields.

Future Directions

Because Photovoice is typically an iterative process with several phases, as opposed to a singular, bounded project, the most obvious future direction is a next iteration of Photovoice. For example,

because one of the themes was lack of equity in STEM, a future Photovoice and/or collage project could explore what that lack of equity *looks like*. In order to avoid operating under a deficit model, another future iteration could include delving deeper into the theme of passion for STEM, where the women coresearchers could answer further questions surrounding this theme through taking photographs and/or art-making. These questions, among other possibilities, may include: Where does passion for STEM come from? What does your passion for STEM look like? What is the relationship between research and your passion for STEM?

Future studies could include utilizing arts-based participatory methods with other underrepresented groups and marginalized communities within STEM fields. For example, similar projects could be conducted with underrepresented minority groups, people of color, women of color, Appalachian communities, indigenous populations, and/or people with disabilities, to name a few. Furthermore, research with larger and more diverse samples using a variety of methodological approaches would help deepen our understanding of this important topic.

Exploring coresearchers' experiences with arts-based research may also be important in determining the benefits of participating in this type of research. Participatory research in general is beneficial to participants in terms of empowerment, voice, and knowledge building/creation (Lazarus et al., 2014; Martin et al., 2016; Vaughn et al., 2017).

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Appendix A: Photovoice Materials

The following materials include the sheet provided to coresearchers during the Photovoice training, the consent form provided for coresearchers to use, if needed, and the prompts coresearchers developed for the Photovoice project.

Photovoice Training Sheet

1. What is photovoice?
   a. Photovoice background
      i. Participatory methodology
      ii. Using photographs to document participants' lived experiences
      iii. Seeks to empower communities to make a positive change
      iv. Photovoice has been used around the world with marginalized communities in a number of different contexts to center around their lived experiences.
   b. Procedure
      i. We will work together to create a photo prompt. You need to take a photograph that responds to each prompt. You are welcome to take more if you feel they are relevant.
         1. This is open-ended. Your photographs can be literal or they can be metaphorical.
         2. It is helpful to take notes on your photographs.
      ii. We will meet next semester to discuss the photographs as a group.
      iii. We will have an exhibit displaying the photographs.

2. Participant consent
   a. By participating in this photovoice project, you agree to
      i. Allow your photographs to be included in the exhibition of this project
      ii. Allow your photographs and discussion quotes to be included in the academic journal article about this project

3. Consent to photograph
   a. If someone is recognizable in a photograph, get their consent. **There is a consent form available in Dropbox.**
   b. The consent form gives several options. The first option is the bare minimum, and if they select only that option, their photograph will not be seen outside of this study.

4. Bystander intervention/photovoice ethics
   a. If you find yourself in a situation in which a person is unsafe, then taking a photograph should not be your first priority.
   b. If it is possible for you to safely intervene, then please do so.

Photovoice Consent Form

I, _____, hereby consent to allow photographs in which I am recognizable to be used in the POWER Photovoice Project. _____ (photographer's name) has explained the project and I understand that my image will be used as part of the project, but I will be given a pseudonym if I am discussed in publication.

I consent to (check all that apply):

_____ Allow my image to be used as part of the project. (Checking this option alone means your image will not be displayed or disseminated in any way and will be seen only by the participants of the project.)

_____ Allow my image to be displayed in the exhibit of the photographs taken as part of this project.

_____ Allow my image to be included in the academic journal article about this project. (This means the photograph will appear in print and at academic conferences.)

I understand that checking the last two options means that my image may be seen by people who may be able to identify me. Additionally, I understand that checking the last two options does not guarantee inclusion in the exhibit or article.

_____

(Signature)

_____

(Date)

Appendix B: Intersectionality Activity

Exploring Self and Intersectional Identity

We all have many pieces to our personal identity that make up the full story of who we are. Oftentimes, we get caught up in the boxes we are required to check for census records, while we inhabit many intersectional identities that fully form our being. This exercise will allow participants the opportunity to consider the many intersectional identities that are uniquely their own. What about those identities is important to their authentic self and illustrate that which is most central to their person? The purpose of this activity is to provide participants the opportunity to see beyond biases and perceptions held about the people who inhabit the space and unlock deeper truths about the unique characteristics which shape our fellow colleagues in the classroom.

1. Introductions
   a. Share what is your day job
   b. Name one identity that you hold and why it is important
2. Activity (see Figure 9)
   a. **Brainstorm**: Each person should receive 10 index cards. On each card, write a word or a phrase describing something that is important to your identity.
   b. **Connect**: Lay your cards out on a desk or surface. Walk around the room, reading what others wrote on their cards. Anytime you see a word or phrase that you also identify with, add a dot to that person's card.
   c. **Reflect**: As a group, discuss what you noticed during this exercise. *Which cards had the most/least dots on them? Did anything surprise you? Did anything challenge you? If so, what and why? Do you feel more or less connected to one particular identity over another? What is one thing you will take away from this exercise relating to your own identities or the identities of others in the room?*
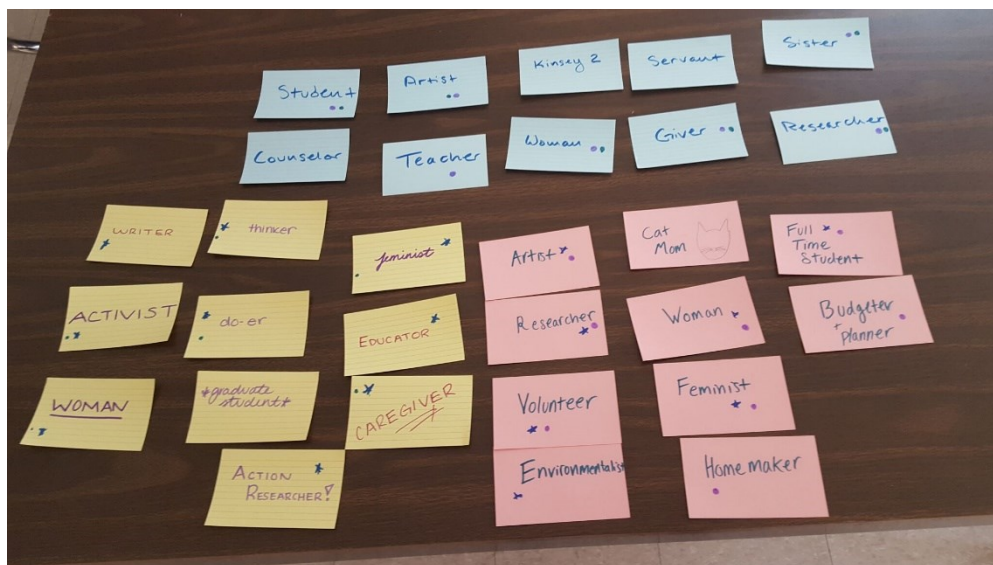
Figure 9. Intersectional Identities